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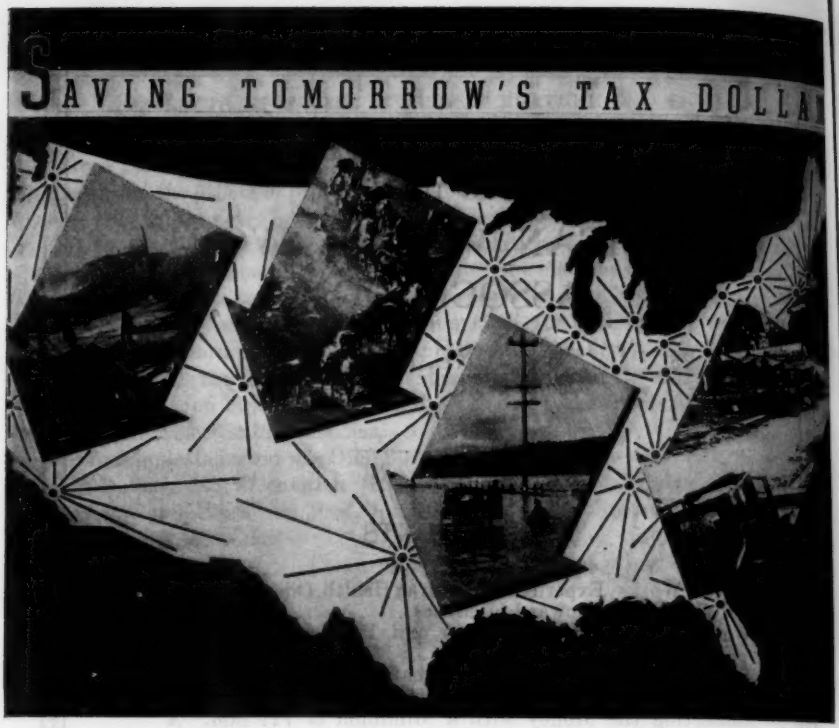

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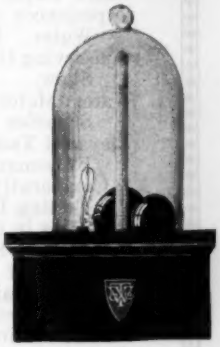

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WATER WORKS EXPERIENCES FROM A HEALTH OFFICIAL'S VIEWPOINT

By Howard E. Moses

(Assistant Chief Engineer, Pennsylvania Department of Health, Harrisburg, Pa.)

The subject of this paper, proposed by your Secretary, is one of those happy suggestions, in that it affords the speaker unlimited latitude to wander at will all over the wide field of public water supply. It had the drawback of making it somewhat difficult to decide upon some phase of this broad subject, being embarrassed by a wealth of material through contact with the problems of some 700 public water works over a span of a quarter century. This was the predicament in which your speaker found himself when one of those fortuitous happenings occurred on a hot August afternoon, which provided a starting point at least.

A request for assistance came from a community having a municipal water works where suspicion had arisen as to the safety of the public supply, and involved in the problem was a rumor of a case of typhoid fever—just a single case of typhoid fever! We responded at once, of course, and found the rumor of disease to be unfounded, fortunately, but this happening evoked recollections of other occasions when journeys were made on similar errands where a different story was unfolded; when this dread disease still exacted its terrible toll.

However, this happening provided a peg on which to hang some recollections of the past, permitting a contrast to be drawn with the present, which will not only give a chance to reminisce—a happy prerogative of the aged—but will serve to give recognition to some of the changes which have taken place in public water supply practice, particularly from the standpoint of public health. Naturally our observations are related to Pennsylvania, but the principles involved apply more or less generally throughout the entire country.

REDUCTION IN TYPHOID FEVER

Just 30 years ago, in 1905, the Pennsylvania Department of Health was created by Act of Assembly. It effected an organization in 1906, and in that year there were 24,471 cases of typhoid fever with 3,917 deaths, a mortality rate of 54.8 per 100,000 population. Last year—1934—there were 970 cases with 125 deaths, equivalent to a rate of 1.3 per 100,000 population. This is a reduction of approximately 97 per cent and represents a saving of over 100,000 lives of persons who would have died had the 1906 rate continued. This same trend has occurred throughout the entire country.

Waterworks men are modest fellows and do not "claim everything and admit nothing," but beyond question of doubt safer water supplies can be credited with being the most potent factor in this remarkable reduction. Other measures, such as milk control, hospitalization, immunization and better education of the public in sanitary habits undoubtedly have contributed, but it is more than a coincidence that extension of safe water supplies almost invariably parallels a reduced typhoid incidence.

There is a temptation to reminisce on such a subject, to relate the many interesting things attendant upon the investigations of epidemics of dysentery and typhoid, to describe the process by which, if one were fortunate, the cause of infection was made reasonably certain, the methods of control practiced immediately and subsequently to prevent a recurrence, to speak with sympathy of the suffering of the victims, the sorrow and tragedy of their deaths, but all those things are a story of themselves and merit the pen of a skillful historian.

For our part, it will accomplish more if we consider causes and effects and measures of control to prevent a repetition of the tragedies of the past. We should not congratulate ourselves too highly on

what has already been accomplished, handsome as is the record. Typhoid fever and other waterborne diseases are not wholly behind us. They are an ever-present menace. Wolman has aptly said, "It should be borne in mind that typhoid fever and other waterborne diseases are not vanishing calamities, but are merely *controlled* diseases which may recur at any time, if there is a break-down in operation of water purification systems."

RISING STANDARDS

Should such a happening occur, it is likely to be serious for any one who may be chargeable with being responsible therefor. Every waterworks man of experience realizes that the public is more exacting in its demands on the management; the people have been educated to expect water of unquestioned safety first of all; they demand qualifications of palatability not insisted upon in years past; they, no doubt, are unreasonable at times, but the fact remains that they no longer will tolerate, at least unvocally, the kind of water we had to use frequently not so many years ago.

For we have better tools with which to work, improved machinery, precise apparatus, wider selection of chemicals, which, in conjunction with greater knowledge of processes, guided by scientific control, enable the production of better water than could be produced under earlier conditions. Frankly speaking, with our present day knowledge of water supply production and barring accidents and emergencies, there generally is little valid reason for not producing a safe and acceptable water supply at all times.

On the other hand, it is freely admitted that waterworks have problems today not recognized, or at least not burdensome to our predecessors. The expanding life of our people has brought attendant problems. Extension of water service to greater numbers entails increased demands on systems which must be met; sources of supply, adequate ten years ago, must be amplified with additional sources difficult or nearly impossible to obtain within practical expenditures; pollution loads on supplies require changed or additional treatment processes; sanitation problems arise, due to our nomadic habits, on watersheds heretofore considered inaccessible to the public. But similar problems have been encountered in the past and I am certain the well-known resourcefulness of waterworks men will find a satisfactory answer.

THE CONSUMER

Thus far we have considered the problem wholly from the side of the water purveyor. What of the consumer and his place in the picture? He likewise has an obligation not usually recognized, or at any rate admitted. Aside from the payment for service rendered, on which there probably will never be complete accord, the consumer can aid in several ways. He can cease polluting our water courses by the discharge of private and municipal sewage; he can uphold the hands of those in authority charged with the responsibility of protecting our streams; as an individual, he should have the decency to observe sanitary practices when travelling over or visiting water supply catchment areas; his carelessness in this respect is notorious and is a serious matter considering the accessibility, by auto over improved roadways, of hitherto remote areas; he can stop insisting on his right to fish in water supply reservoirs. Finally, he can show some appreciation of a difficult task well performed by the men who, in the fact of oft times staggering difficulties, maintain for him an uninterrupted flow of this necessity of life.

That suggests the thought that the average consumer knows little of the task performed daily in producing his water supply. Why not take the public into your confidence? Suitable publicity can help wonderfully. From the July, 1935 News Letter of the Pennsylvania Water Works Association, I quote a few thoughts of President Murdoch on this point:

> "We need new friends and we need to hold those we have. The friends referred to are our consumers and the public officials in the communities in which we serve. The most important job ahead of our companies is the building up of good relations with these—our customers and our neighbors.
>
> "Your President is not an advertising expert but, as an amateur, it seems to him that some of our companies are accomplishing good results with some carefully considered, expertly prepared, publicity.*** "

It will help. Public health has been sold by unremitting educational efforts until now it is recognized, alike by courts and laymen, as being of paramount importance. Safe water is a cardinal principle in any such program.

CHLORINE

But we should speak of other things such as the use of chlorine, the development of which on public water supplies has all occurred within the quarter century under discussion. As you are aware, it

was first used on an unfiltered supply at Boonton, New Jersey in 1908. The following year an installation was made on one of the Scranton, Pennsylvania supplies. In the early days there was very definite antipathy to the use of chlorine in connection with public water supplies. It was considered a poison, and many towns rebelled when its use was suggested. Doctor Samuel G. Dixon, the first Commissioner of Health of Pennsylvania, gave his consent reluctantly to its use as a disinfecting agent, and for many years the Health Department permits approved chlorine treatment only as a temporary measure. In spite of the opposition, chlorine has established its place in waterworks practice, and its use is now taken as a matter of course.

However, the early aversion to adding chlorine to drinking water has not died down entirely and opposition still exists, particularly in connection with wooded upland supplies in mountainous regions, infrequently visited by humans, where chlorination is indicated as a safeguard because of the danger of accidental contamination. These are usually small waterworks where the demand practically ceases during the nighttime, and with the older type of apparatus it is difficult to secure a variable dose, with the result that overdosing occurs and in the morning the water consumer is treated to a chlorine cocktail, much to his disgust. With the improvements already effected and still progressing in the development of automatic equipment, it is anticipated that much of this trouble can be overcome.

Regardless of such scattered opposition, the principle has become fairly well established in the minds of both the profession and the general public that no surface supply is safe at all times without disinfection, regardless of the remoteness of the watershed.

In connection with filtration, chlorine is indispensable, and much development in its use has taken place. By experiment, different methods of applying the chlorine have been evolved, and today we have prechlorination, post chlorination, super chlorination, and chlorine used in conjunction with ammonia.

However, in this connection it is advisable to keep in mind that chlorine should not be considered as a substitute for filtration, but as a valuable adjunct. There has been a tendency to rely too greatly on the use of this chemical to assure the safety of the water supply, and its real purpose has been lost sight of, namely, that it should be a factor of insurance in addition to adequate filtration—not in lieu thereof. The tail should not wag the dog.

FILTRATION

Many changes have occurred in filtration plants themselves. Filters of the pressure type are no longer installed on public water-supplies, at least in Pennsylvania. This is also true of slow sand filters in this part of the country. The last large slow sand filter in Pennsylvania was built in 1913 at Reading. Everything is in terms of the gravity rapid sand type filter today. However, the designer has a much broader field from which to draw. There is a greater range of equipment—types of precision apparatus unknown to the earlier filter plant man. He may select from a long list of chemicals; his plant may be provided with machinery-equipped mixing basins; the sludge from his settling basin will be removed automatically; the filters are provided with a different type of filter bottom and are designed for a high velocity wash. We have better knowledge of the use of chemicals in water treatment, and above all, scientific laboratory control has become the thing on plants of any considerable size.

MORE COMPLETE TREATMENT

Latterly, more attention is being given to refinements in water treatment. The householder is no longer satisfied with merely a safe water, but it must likewise be of good appearance, reasonably soft, non-corrosive and free from obnoxious tastes and odors. Accordingly, plants are springing up providing facilities for water softening, for the removal of iron and manganese, with facilities for aeration, for carbonization, and various other things—all for the purpose of providing a more acceptable water to consumers.

STANDARDS OF QUALITY

There is need for clarification in the matter of standards. Drinking water standards adopted by the Treasury Department, usually referred to as Treasury Standards, are more or less generally accepted throughout the country, but there is no absolute compulsion to do so. Consequently, there is some uncertainty as to exact standards of quality of water supply, which leads to confusion. Much work has been done since the first edition of Standard Methods for the Examination of Water and Sewage was issued in 1904. This invaluable publication is now in its Seventh Edition. However, while basically most analytical practice is in conformity with the procedure set up in Standard Methods, there are departures there-

from which give rise to arguments as to their validity, into which matter your speaker has not the slightest intention of entering. It would be desirable if we could have one method that everybody could follow. To say the least, it would produce comparable data, which are lacking at present.

The heartening aspect of this phase of waterworks practice is that laboratory research work is being carried on extensively; new facts are being discovered, leading to better knowledge of water purification. Much attention has been given by the research men to a differentiation of the various types of bacteria. For example, an effort has been made to find some positive test to identify bacteria as to their fecal or non-fecal origin, and progress is being made in this direction. Meanwhile, old B. Coli Communis is still a "Communist," since he waves the red flag of pollution and no one wants him or his relatives in a water supply, regardless of the route they follow to get there.

PLANT BEAUTIFICATION

Plant beautification is coming into its own. Years ago little attention was given to the appearance of waterworks. Today the waterworks management realizes that it is a valuable asset to have a nice looking plant with the buildings located in a landscaped area rather than some of the ramshackle establishments so common years ago. Unquestionably, this has an effect upon the public, psychological perhaps, but nevertheless real. One naturally would expect to get a better water supply from a nice looking plant than from a waterworks where there was evidence of lack of care in the appearance. Unquestionably, this must have a good effect on the operators themselves as well as on the public, and it does not mean that heavy expenditures are required to accomplish this end, but care in the architectural design of the buildings, the spending of reasonable sums for beautifying the surroundings and, above all, good housekeeping, will go a long way towards accomplishing the desired result.

TASTE AND ODOR

There is probably nothing in the service of public water supplies which will bring a quicker reaction than nasty tasting or loud smelling water. Twenty-five years ago, and later, the public as a whole accepted the occasional presence of obnoxious tastes and odors as something that had to be tolerated the same as muddy water, but

that is not true today. Every waterworks operator present here knows the immediate result, by way of complaints, when bad water is served.

Aside from the inconvenience, such a situation does have a health aspect, which has been observed frequently by health authorities. If it is at all possible to secure another supply, the average consumer will not drink bad tasting or bad smelling water, even though it is bacterially safe. He will resort to other supplies more palatable but perhaps of dangerous quality, sometimes with dire results. Just last year, in the western part of Pennsylvania, a typhoid fever epidemic occurred in a mining village where the public supply was objectionable, although safe, and the citizens resorted to the use of springs, at least one of which came under suspicion as having become infected with typhoid fever germs and as being responsible for the outbreak.

This antipathy to bad water has brought about extensive development of control processes, some of which have become routine measures in plant operation. Thus some waterworks with impounded supplies systematically dose with copper sulphate for algae control and are routinely on the outlook for the appearance of these troublesome growths. We have new agencies in activated carbon and ammonia-chlorine for taste and odor control. Industries are coöperating with health and waterworks officials in either treating their wastes or, in some instances, actually keeping them out of the streams. Outstanding examples of the latter are wastes from gas plants and by-product coke works. This is not a closed chapter, however, since industrial wastes are still being discharged into streams, road oil occasionally drains into water supplies, accidents occur at coke plants and gas works, all of which tax the vigilance and ingenuity of the waterworks operator to avoid serving an unpalatable water supply.

In passing, mention should be made of the campaign undertaken within the last two years in connection with coal mine drainage, the discharge of which has been so ruinous to miles of streams and has added to the operating troubles as well as to the financial burdens of so many waterworks, particularly in the bituminous coal region. With Federal funds and as a relief measure, a fairly good start has been made along this line in the sealing of abandoned coal mines, and it is claimed that the beneficial effect on some streams can already be noted. However, much remains yet to be done, since the work has just fairly been begun. It is believed that this activity will soon be resumed on a large scale.

UNSOLVED PROBLEMS

Gratifying as has been the progress in the last quarter century, there are still many problems to solve. To mention just a few, further safeguards are needed for watershed protection; difficult waters demand new processes; we must learn how to handle certain industrial wastes. Are there elements or substances in our water supplies, perhaps toxic, detrimental to public health, of which we have little definite knowledge; what practical methods are we going to use with regard to cross-connections; what policy is to be followed as to water supplies in factories and hotels which, of themselves, are equivalent to those of fair-sized towns; how can we improve the quality of operating personnel—is licensing of operators the answer to this question; what can be done in the matter of better keeping of records so that we have comparable results instead of masses of information, valuable but not readily analyzed?

These and many other things are confronting the waterworks profession today, in all of which the health authorities have a very definite interest. Consequently, none of us need think that the problems of public water supply are by any means all satisfactorily solved. There is not only a task to accomplish, but there is a challenge as well to everyone interested in the production and service of this commodity which, next to air, is the most common one we have and at the same time the most needed. We have a goodly heritage handed down to us by our predecessors in this field, and I am certain, from observations extending over more than a quarter of a century, that the waterworks fraternity will attack these problems with the same zeal and fidelity that has characterized our profession in the past years.

(*Presented before the Central States Section meeting, August 22, 1935.*)

WATER SUPPLY, PUBLIC HEALTH AND POLITICS

By H. E. Jordan

(*Indianapolis Water Company, Indianapolis, Ind.*)

There are today in the United States something over 10,800 public water supplies serving 11,900 or more communities. Both figures lack precision because of the constant changes. New water systems are being built, consolidations both of water systems and organized communities continue. In 1934 the water systems then installed served 63 percent of the total population of the country. Fifty percent of the total population of the country or 80 percent of the city dwellers having public water supply available were served from systems under public control. The balance of the water systems were under private management.

Broadly speaking, water supplies, however owned, are, in their interrelation with public health activities, affected by the qualities of municipal administration. Even though a water plant may be privately owned, the full value of that management may not be attained if the city government or public health activities are illy administered in the community it serves.

THE MUNICIPAL ELECTRIC FIELD

No country wide study of municipal water supply administration is available. At a time such as this, when the national administration's activities are extending government control into so many new fields of endeavor, it is to be regretted that so little is known in an inclusive way concerning this venture into municipal public service which has as a background more than a hundred years of experience. Lacking such an investigation of the water supply field, where may we turn for correlative information? What other branch of publicly controlled municipal service has been scanned where the implications of that study bear upon water supply administrative practice? Fortunately just such a document is available. Public Administration Service Bulletin No. 38, published in 1934, is titled "Municipal Electric Plant Managers." It relates only to "Managers," their

training, appointment, tenure, etc., and does not extend to "Employed Personnel." But even with this limited scope, it is informative and challenging. There were in 1934, 1800 such plants, 70 percent of which were located in towns of 2500 or less population. Of those Managers returning data, 46 percent were appointed by the City Council, 24 percent by the Mayor or City Manager and only 24 percent by special boards or commissions.

In those communities where both generation and distribution of electric current were controlled by the municipality, 24.8 percent of the Managers had served less than 3 years, 43 percent less than 7 years and 66.7 percent less than 10 years.

What preparation did the Managers have for this responsibility? It is significant that in the cases where the Manager had not previously been in public service, less than 40 percent had been previously employed in the electric industry. Of those men who were appointed after serving in some other public capacity, less than half were advanced to the management position from a subordinate position in the same plant. Of all the Managers replying less than 25 percent had completed a high school education and less than 10 percent had a college education.

Let us rephrase these figures. What do they tell us? First, that only one of every four plant managers was appointed by a board, presumably non partisan. Three of every four owed their appointment to a Mayor or the Council, both definitely partisan. Only a third had served as Managers for 10 years and almost a third had served less than 3 years. From this latter group, we learn that 40 percent of their predecessors served less than 5 years. Finally we note that less than one in four had completed his high school course and less than one in ten was a college graduate.

We cannot avoid making several observations concerning the above figures. First, we face again the prime travesty of American Municipal methods—that governmental positions, whether the tasks be pure administrative or whether they be technical, are likely to be regimented in the spoils list of the currently dominant political party. In only the minority of cases have the communities bestirred themselves to the point that there has been set up a special board to control the electric plant and personnel. It is not sentimental nor is it visionary to hold the idea that even in the case of pure administrative functions of government some sort of training and experience background is important. Certainly there should be no serious dispute

of the idea that when the public service is technical, the selection of the individual to render that service should be primarily based upon technical ability and only to a minor degree, to partisan political considerations.

The evil fruit of political mindedness is shown by the brevity of management tenure. Think of it—a third of the Managers with less than 3 years tenure, and they were successors to men, 40 percent of whom served less than 5 years. Adding to the public injury, we find that less than half the men entered municipal electric management with any previous contact with the electric industry and of those who had been previously in public service less than half were advanced from a subordinate position in the plant they managed. As to basic education, we must couple the fact that only one in four was a high school graduate with the further fact that for nearly a generation, in most of the States where municipal electric plants are plentiful, school attendance to age 16 has been enforced by law. The intelligent 16 year old boy with any natural aptitude for mechanical things has been pretty well through high school before the law would let him quit. However freely we might admit that subordinates in such plants might function fairly adequately without having followed through organized education to the point of high school graduation, it appears a sad commentary upon the city as an agent of education that it so illy manifests the validity of its work that the city as an agent of government and public service does not require its electric plant managers to be better educated men than is now the case.

THE MUNICIPAL WATER SUPPLY FIELD

It is dangerous to apply too directly these figures from the municipal electric field to a study of the municipal water supply field. There were 16,661 incorporated units of government in the United States in 1930, of which 3165 or nearly 20 percent had a population over 2500. The 30 percent of municipal electric plants existing in the cities of this same class off hand indicates that the chance distribution of such enterprises trends toward the larger cities. But we know that municipal control of electric service in the towns over 25000 is in the minority and, municipal control of water service in similar sized cities is in the majority. In water works practise the larger city does tend to give some recognition to the value of technical training and experience although one is dangerously near an expression of wish fulfillment if he attributes any great momentum to such a

tendency. Too often we learn of the rigorous application of the spoils system to practically the entire personnel in cities of from 100,000 to 750,000 population, with the attendant periodic destruction of whatever organization and experience values may have grown up since the last upheaval.

In that larger group of communities of what we may term the county seat class, our contact with the fields leads to the conclusion that political control dominates, tenure of management and responsibility is brief and little recognition is given to the values derived from acquaintance with the job or to the more fundamental human values evidenced in an individual who has completed successfuly public school or college education. In other words, the facts above recounted concerning municipal electric plant management, are probably not so far from the fact of municipal water plant management as we should hope to find true.

In Indiana, during the past three years, each year's beginning has witnessed the displacement of one of every five water plant superintendents. One community has entrusted its water supply to a man, who, however reputable and conscientious he otherwise may be, by his own admission exhibits a somewhat major limitation, in that he is unable to read the communications sent him by the State Health Department.

STATE HEALTH DEPARTMENT LEADERSHIP

The knowledge that such conditions exist in many States of the Union, makes many, who are acquainted with the development of a professional spirit in the well trained personnel of State Health Department Sanitary Engineering divisions, satisfied that the importance of their work must be more fully recognized. At the turn of the century many State Health Departments had in their executive secretaryship, forceful and picturesque individuals who did a tremendous service in interpreting to the public the rapidly growing mass of basic facts concerning personal hygiene and environmental sanitation. Then there swept across the country, a wholesome development in food and drug control. A new group of leaders became influential and under their direction unsavory practices in food production and the adulteration or false advertising of drugs were put under control to the great benefit of the public. One apprehends that there is now a definite need for a rebirth of the spirit under new leadership.

But a number of factors make the Engineering Division of State Health Departments more important at the present time. The automobile has made mass travel easy. Parks and recreation centers have greatly increased in number. Public health engineering is related not alone to the fixed community such as the town or city but to the fluid community represented by every tourist center.

In addition to these facts, we must recognize that in their supervision of public water supplies and sewage treatment the State engineering staffs are many times the only barrier against the dangers from mistakes made by untrained personnel in control of municipal water plants. There is nothing visionary about this. It is pretty well demonstrated that of the typhoid fever and dysentery which has affected our urban centers in recent years more than half of that which was traced to water supply was found to be the result of improper control of purification processes. We must admit the human tendency to make mistakes, but since we know how unsubstantial is the basis of appointment to such positions, how little attention is given to training, and how little real authority many a plant manager actually has over his subordinates, we must lay at the door of spoils politics the discredit of most of these epidemics which have occurred.

It is to the great credit of purification plant men over the country that they have recognized their responsibilities to their communities much better than have the communities themselves and may be found willingly engaging in training courses leading to licensing, to the end that the standards of their class of work may be increased. The sanitary engineering staff in many States is the welding power that permits these operators to gather, study and to prepare themselves to meet successfully the problems which must be met in their daily activities.

It is all the more important, then, that state officials should recognize the vital need of these engineering staffs for strong personalities, for well trained men adequately supported in their official acts if we are to have more efficient control of water supplies and community sanitation. All the more should party leaders be reluctant, simply as an incident in a political overturn, to break up an efficient engineering staff and replace it by another group, who, no matter how capable its members may be, are limited in their activities and efficiency by the very train of circumstances which led to their appointment. No intelligent citizen can ever support a civil service system which makes tenure safe for the stupid, the lazy or the incompetent. But

if urban life is to be made safer, the agencies which are responsible for water supplies need to feel that training for and efficiency in the performance of duty are increasingly the essentials upon which public service is based.

Turning to another phase of the situation, all public health work in the United States is performed at an expenditure of about one dollar per capita per year. Leaders in the profession state that the real and reasonable needs of a public health program call for two or three times as much money. And while the professional aspect of public health administration is generally recognized by the appointment of a physician as the department executive in American cities, even the amateur observer soon notes that the subordinates in these departments too frequently are that "here today and gone tomorrow" fruit of the political plum tree whose training for public health work is vote collection in the precinct.

THE INTERRELATION OF PUBLIC HEALTH AND WATER SUPPLY WORK

The essential theme toward the demonstration of which this discussion is directed is that professional public health work and water supply operations are not travelling down separate roads dealing with unrelated problems, but that they are simply variations in the form of effort directed toward one broad objective—environmental sanitation. How well either or both meet the needs of the people lies first with the people themselves in their choice of public administrators; secondly, with those administrators in their choice of men to carry on public health and public water supply activities; and finally, in the manner that the men appointed to this type of work understand the relation of their particular task to the final objectives. The need for integration, for coördination of viewpoint and of effort becomes manifest to many of us at that point where the public water supply is turned over to the private consumer. At that point the water utility—either privately or publicly controlled—meets face to face that still individualistic product of democracy—the customer. That customer may have chosen, for reasons which may have validity only in his own mind, to provide an auxiliary water supply—generally from a well. We know that however critical that customer might be about the public supply, he has the most benign indifference to or complete assurance in the good quality of the private supply. The farmer of the earlier days who defended his barnyard well, even though its product smelled of manure, was not one bit more resistant

to reason than the metropolitan hotel owner who furnishes his guests at the table a water that is brackish from the sodium chloride in the urine leaking from the city sewers.

The customer may not have a private supply, but he may have cross connected water pipes and sewers "ad lib" within his property. This often appears to be done upon the theory that water pipes are always under pressure and that sewage always flows away. That the water pressure may not always be effective at all points on his property the customer knows. That sewers sometimes back up he also knows. That the connections he or his employees have made may be dangerous he does not recognize. The current (February, 1936) issue of the Journal of the American Water Works Association contains 42 pages of as valuable and informative data concerning plumbing hazards as have ever been published. Their perusal will indicate the many ways in which faulty plumbing practice may set up hazardous conditions. It will cause the reasonably informed reader to realize that a new line of defense must be set up if the public is to be protected. And here is where the coördination of effort is necessary.

Assume if you wish, a water department staffed with thoroughly competent personnel rendering service fully adequate from both the physical and sanitary aspects. Visualize a State Health Department Engineering staff unhampered by the vision of the Damocles sword after an election, fully competent professionally and capable of doing the work such a State Department can properly do. There are still gaps in the chain of protection for the individual.

PLUMBING HAZARDS

Two things more are needed before an integrated attack upon the whole problem of water service sanitation can be made. The first and most imperative is increased competency in the sanitary inspection staff of municipal health departments. Today one thing is startlingly evident. What has been done in a few cities in studying plumbing hazards needs to be done in every American city. This statement bears its own corollary. That study needs to be organized as a permant inspection service—because the problem is not static. It is as continuous as the problems of fire fighting. And without any offense implied or intended, our municipal health departments do not today appreciate this problem that is laid at their doors and which they, by no form of reasoning, can place on any other door-

step. It is theirs to handle. If they handle it, we shall see an integration of water supply sanitation down through the state authorities and through the water department clear into the customers premises where the municipal health agency sets its own house in order. If they do not handle it the chain of protection is not to be welded into an effective unit. The elimination of plumbing hazards in hotels, hospitals, dairies, office buildings, factories and stores is not a thing which can be dealt with effectively by state agencies. Nor is it proper to expect a water department to do the health departments' police work. It is emphatically a municipal health department problem, to be solved or not to be solved just as the municipal health department functions or does not function adequately.

Lest our Federal friends feel too comfortable, it may be observed that although the installation of cross connection protective devices is required by act of one branch of the Federal service, the most stubborn and indifferent resistance to correction of plumbing hazards is found in various Federal departments whose buildings are scattered throughout the cities.

THE EDUCATION OF THE PUBLIC

The other thing that is needed to accelerate integration of water supply sanitation is wider popular understanding of just what the inadequately controlled dangers are. The medical profession, the teaching profession, the womens clubs, the civic clubs all need more information. The plumbing trade has seemingly been both unaware of its purely selfish opportunities to get business as well as non responsive to its social responsibilities in its failure to see its relation to the problem. Building managers, hotel owners—all that group of people who deal with concentrated transient masses of people under one roof, must learn a lot about the relation of pipe sizes and peak demands to the integrity of water service. They must know that the fellow who does not know the gun is loaded and the plumber who cross connects the water line to the sewer are potential partners in manslaughter. Many, many things need to be popularized for general understanding before the dangers are reduced. Efficient state sanitary engineering staffs, well trained water plant personnel, intelligent municipal health department employees and an understanding public. Will they ever meet?

"Water Supply, Public Health and Politics"—what a lot of loose ends there are. Will they ever be gathered up into an orderly fabric?

I am no Pollyanna—nor can I apply Dr. Coué's "better and better everyday" formula. The evident need is for more competent public service. Robert Moses in the Saturday Evening Post (November 12, 1935) finds a response when he says:

"Let us be frank about it. There is no well established tradition of competent, honest and enterprising public service in this country today, and there is no likelihood of establishing it on the gigantic scale now contemplated within any reasonable time."

"We only began to depart from the straight spoils system fifty years ago in the nation, and the new tradition is not well developed yet. The top of the service, up to 1932, was still largely political and partisan, and there were an immense number of exempt positions throughout the country. Since 1932, thousands of new positions under the Government throughout the country have been filled without competition of any kind and for purely partisan, political or personal reasons. Many states have no competitive system even now, and the overwhelming number of municipalities, including counties, townships, cities, villages and special districts, still fill their public jobs largely on the old spoils basis. It takes generations to build up a finely trained, alert, honest and efficient Government personnel; and in a vast country where few people have been brought up to respect it locally, the beginnings of a national system can be pulled down almost overnight."

Shall we look forward to competency and enterprise in public service? Shall we especially look forward to a beneficial integration of water supply, public health and politics to the end that the problems of environmental sanitation are met within the limit of the knowledge available?

We are entitled to all the forward looking we choose. We can all keep busy emphasizing the needs and indicating the steps required. If we remember that in the long term, humanity, phoenix-like, rises above the rubbish of its past errors, we shall not become too cynical as to the attaining of greater coördination in environmental sanitation.

(*Presented before the Indiana Section meeting, April 9, 1936.*)

BETTER FIRE PROTECTION FOR THE SMALLER COMMUNITIES

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This title offers an extensive subject to explore. There is a definite and proper distinction between fire protection and fire prevention, but even after fully considering this distinction the scope of the subject remains broad. It may involve both municipal and private protection; it may involve the construction of new protective facilities of any or all kinds, or it may only involve the minor improvement, or even just the better and more effective utilization of the facilities already provided. Such construction or changes may be in water systems, fire departments, fire alarm systems, protective features in buildings in general or automatic sprinklers, or some of the many other special fire-protective devices in individual buildings. Since we are thinking mainly in terms of water supply, this discussion will be largely limited to this feature.

Fire protection is the primary consideration in the design of the entire water system, both supply works and distribution system, in the smaller communities which we are to consider. Requirements for fire flow in communities of various sizes have been long set up and generally accepted, and consumption demands in the smaller communities are never more than a small fraction of the amount necessary for fire flow. Whether in designing a new system or in planning changes or additions in one already in service, there are certain fundamentals which should be kept carefully in mind. It is not economically possible in these smaller systems to attain the degree of adequacy and reliability which may be readily reached in larger systems, but there are many things which can be done at reasonable cost to improve materially the systems which have been commonly installed in the smaller towns.

A typical example of such a system, in this territory, in a town of

up to 1,500 or 2,000 population, is one consisting of a single well equipped with a deep-well pump of perhaps 300 to 400 gallons a minute capacity delivering direct to a 6- or perhaps an 8-inch main which extends to a 50,000-gallon elevated tank. From this principal feeder are loops and dead ends of 4- and occasionally 6-inch pipe supplying the built-up districts and some 2-inch giving domestic service in districts which may have once been scattered but are now well built up. Such a system is operated by intermittent pumping at from 45 to 55 pounds pressure and usually with a wide range of fluctuation in the amount of storage in the elevated tank. Power is usually entirely electric with lines overhead in alleys and subject to severe exposures from the buildings along its route. The pump is housed in any sort of an available building or shack which may be utilized. Such a set-up, with the added handicaps of small hydrants with high friction loss and usually of obsolete type and gate valves few and far between, provides far from a reasonable degree of fire protection to such a community. In addition, maintenance has often been neglected, particularly in the distribution system, and some valves are closed or hydrants are inoperative.

REVIEW OF SYSTEM

Let us take this hypothetical, but rather typical, system and see what can be done with it to provide better fire protection. First and foremost, we can go over the system from one end to the other, making sure that each and every part of it is in the proper condition so that we can get the best possible utilization from the facilities which we have. This sounds like a trite and obvious statement to make, but there are unfortunately many, many instances where it is not done, both in the smaller towns and in some that are not so small. Detailed suggestions on the value and methods of inspection and maintenance will doubtless be given in the papers which are scheduled to follow this. In connection with this same thought, we can revise our operating procedure, studying the time or times of operation of the pump so that more of the storage in the elevated tank will be certain to be available for fire. We cannot choose the time when our fires will occur, but we can arrange to minimize fluctuations so that whenever the fire does occur we shall have as much water as possible to cope with it.

Having placed our system in the best possible condition to utilize what we have, the next step is to consider what the first step shall be

to improve it to provide better fire protection. Our hypothetical system is weak and inadequate; it can deliver under best conditions only one-half or less of the fire flow required in even the smallest towns. The thought of remedying this inadequacy should be considered first. This might be done in at least three feasible ways: The first consideration might be to increase the amount of elevated storage provided on the system; an alternative method of doing this would be to drill additional wells and equip them with pumps delivering direct to the system; or, still another alternative to attain the desired results would be to construct a suction storage reservoir to be kept full by bleeding from the discharge of the existing well and equipped with a pump to deliver the storage at the time of fire.

Storage

In flat country the first method is impractical, although in hilly country where a suitable elevation is available for a storage reservoir of good size it is by far the best method, as any unreliabilities in all the previous steps of securing supply are offset by elevated storage which is instantly available for fire.

Additional water

The second alternative, of providing additional wells delivering direct to the system, sounds offhand to be the best and most logical method to adopt, but careful consideration will show that there are a number of features which keep it from being fully desirable, from the fire protection standpoint, or economically feasible. Such wells would not be at all necessary for domestic consumption; the one in service is more than ample for all of that. In all probability they would also be entirely dependent on electric power and thus subject to all the unreliabilities that the original well is. Pumps would have to be provided for each well and designed for the total head to operate from the level of the water in the ground to the full mark of the elevated tank.

Better pumping facilities

To meet demands purely for fire purposes a ground storage reservoir kept full from a well or wells and supplying a fire pump has many advantages. Such a reservoir, in the towns of under 2,500 population should have a capacity at least a little in excess of the amount necessary for fire flow for five hours; in the larger cities and towns, for a

period of 10 hours. In our typical small town this would require a reservoir of around 350,000 gallons capacity, but a greater amount than this should be provided if possible to insure against interruptions of supply in the well or well pump, and allow consumption to be supplied while repairs are made without cutting into the fire reserve. If only one fire pump can be provided to utilize this storage, it should be of a capacity such as to make up, together with the well pump delivering direct and the normal minimum elevated storage distributed over 5 or 10 hours, the full fire flow rate required. This pump should not be dependent upon electric power for operation; gasoline engine drive is probably the most feasible as the unit will only be used infrequently for test and fire purposes, and economy of operation does not need to be considered as it would in the case of a pump running continuously. In providing this second source of power we shall have attained an additional element of reliability by having a portion of the supply available in case of interruption to either form of power for any of the many possible reasons.

It would be still more desirable, in planning our proposed fire pump capacity, to divide it into two pumping units, each of one-half or more of the necessary capacity so that the repair of either one of the pumps will not cut off the fire supply, but will still allow a fair amount to be delivered. These pumps should preferably be provided with separate and distinct sources of motive power. Inasmuch as such pumps will not be called upon to deliver direct from the wells to the distribution system, they need only be designed for a head necessary to pump from the suction storage to the elevated tank. Pumping equipment can be housed economically and safely in a small building or pit of fireproof construction, possibly utilizing one wall of the suction reservoir for part of the building.

Distribution system improvement

The next important step, and one which will often have to be carried out before any of the benefits of additional storage and pumps can be realized, is to make a study of the distribution system and see that it has sufficient capacity to deliver the water which we have made available from the pumping station to the mercantile district where the majority of the values to be protected are located. In some cases there may be sufficient capacity, but in most instances additional mains must be laid. In making the design and plans for these we must constantly keep in mind that ever-present factor of reliability

which, under normal circumstances, can only be achieved by duplication. In the small town which we are thinking of our new feeder may very likely be only 6-inch, but we can take just as much pains with the installation layout of this as we would with a much larger main. Find a separate route to the mercantile district, if possible, and provide both the new and existing mains with gate valves so that no break will ever cut off both of them. Especially at the pumping station must we guard against such a possibility; our old domestic pump and the one or two new fire pumps should be connected to the two discharge mains so that no break will affect more than one pump and one main. An additional refinement is to keep the repair of any single valve from interrupting supply completely; this can often be done at the expense of only one or two additional valves. Much ingenuity may be used in working out a perfect condition in such cases; each particular layout requires the closest study in order that the desired result may be achieved most economically.

The size of the mains to be laid will be governed by local conditions, the pressure which will be carried at the pumping station which, in turn, is governed by the heights of the elevated tank, and, of course, by the amount of water which has to be carried. Where the capacity required in a large town is equivalent, say to a single 12-inch pipe, much greater reliability can be attained by installing a loop of 10-inch, with incident benefits accruing in better protection of the properties along the routes of each side of the loop.

ADDITIONAL NECESSITIES

We are beginning to reach the point in our theoretical system where we might feel fairly well satisfied with the fire protection we have provided, but we must not be too complacent. There still remains much in the way of improvement that is fully justifiable. We still have only one well and, while that may not fail or need to be pulled for a long time, when that time does come, very likely it will be without much warning. While we are pulling the well and fitting new casing or when we find that fine sand has clogged our gravel so that difficult and often ineffective measures must be undertaken to get the water through this obstruction, there is going to be delay during which our storage, which has been provided for fire, will be used up to supply the domestic needs of our people. Therefore, we should plan to provide a second well before such a situation arises; this one should discharge into our suction reservoir so that we can

avoid the loss in efficiency, however slight it may be, which we have in wasting the full discharge pressure when we bleed from our direct-pumping well to circulate the water in the suction reservoir.

The distribution system will always deserve some attention. There are probably many dead ends which can be eliminated without much difficulty, overcoming the weakness of supply which is almost invariably found when small pipes are supplied from only one end; these should be listed in the order of the importance of the districts which they supply, and one or more eliminated each year. There probably is 4-inch pipe in long stretches and in compactly built sections where the local protection is much reduced because of the small carrying capacity; these should also be gradually replaced. Take a map of the system—it is assumed that you have a complete and accurate map of the system by this time—and sketch on it with various colored pencils the lengths of main in each shut-off section. When completed some of these may surprise you; the area which might have to be shut off from fire protection by some single pipe line break or repair may be much greater than you suspect. Keep this map in front of you and each year slip into your budget an item for one or two new valves. Borrow the valve-inserting machine from your neighboring city and start cutting the longest sections in halves. It will not be very many years until the worst of them are under control.

Fire hydrants

Similarly consider your hydrants; probably there are many gaps in hydrant distribution brought about by excessive economy in the original installation or by new construction in areas which were vacant at first. These should be filled in as rapidly as possible as it is certainly far more efficient to run fire supply through the pipes of the water system as far as possible towards the point of use rather than to try to deliver it through 2½-inch fire hose, with its high friction loss, cost of buying and replacing, and, because of the time necessary to stretch long lengths. Are the hydrants in your most important and congested districts the oldest, most obsolete and unreliable on the whole system? Most probably they are. Those which are set on 4-inch mains in residential sections had best be left until the time when these mains are replaced, but those on larger mains or in the mercantile district should gradually be changed to hydrants of a modern type, having low friction loss, with suitable large outlet for

fire engine supply and, in general, of full efficiency to fittingly complete the task of the water system of delivering water to the fire department. It is expecting a good deal to anticipate reliable and fully efficient service from hydrants 30 or 40 or even up to 60 years old, but many cities and towns seem to expect it, not only for the present but for the same number of years in the future. We should consider that these old soldiers have done their duty fully, and give them an honorable retirement.

LARGER CITIES

We have taken a hypothetical example with conditions similar to those prevailing in many towns ranging in size from the smallest which may be expected to install water systems up to a population of nearly 2,000, and have discussed the steps which may be taken in providing better fire protection.

Let us now consider the cities and towns of larger size. For these a similar line of study and reasoning will apply although in many of the features more complications will arise. Primarily we should strive to make all steps in the furnishing of the supply fully adequate to deliver the maximum consumption demands and the required fire flow to the mercantile district. The consumption demands are still but a small part of the fire demands and in a town having a well supply probably the best and most effective method of furnishing supply for fire is by storage, usually in suction reservoirs, but elevated if possible. Similarly in towns with purification plants additional clear-water storage will supply the fire demand effectively and at far less expense than an addition to the entire purification works. The question of pumps is usually more complicated; the most important point to hold in mind is to keep the total pumping capacity divided into small units so that the repair of any one or two units will not seriously cripple the protective facilities. Again, two forms of power supply are usually essential for reliability of operation; gasoline or Diesel engines or a reserve steam plant may furnish this duplication. When steam is depended upon for reserve power supply it is of paramount importance that the plant be put into service and equipment operated to capacity once a month to assure that it is kept in condition to be used if and when it is needed.

Principles as laid down previously for the design and layout of arterial feeders in the distribution system likewise apply in consideration of the larger towns. The necessity for cross-connecting long,

unsupported lengths of minor distributors is introduced, and the discussion for improvements in 4-inch pipe, dead ends, better spacing of gate valves, and spacing and suitability of type of hydrants all apply in the larger towns with even greater force. In all of the larger towns and cities additional complications in distribution system design are introduced by the presence of lesser centers of high fire demand around the industrial plants, warehouses, schools, and institutions, any or all of which may be located in such a way as to require the extension of supplementary feeders to properly protect them.

All of these problems warrant careful study and consideration by water superintendents and their consulting engineers before the definite adoption of plans. The engineers both of your own state inspection bureau and of The National Board of Fire Underwriters are not only willing but anxious to have the opportunity to review the plans of proposed improvements before their adoption. It is truly discouraging to be called to a town and proudly shown some completed improvement only to find that through being too close to the project those in charge have failed to note some flaw which largely nullifies the value of the improvement in fire protection. This implies no criticism of anyone involved; there are so many angles present in any fire protection improvement that it is practically impossible to be sure of having covered them all. Even our staff of fire protection engineers, specializing in such things, sometimes discover on a subsequent inspection something rather important which they have missed entirely the first time.

IMPROVING OTHER PROTECTIVE DEPARTMENTS

While on the subject of better fire protection, we should not neglect the important thought of keeping other protective departments in somewhere near proper balance with the water system. We have accomplished little or nothing if we have built up our water system to a point where full fire flow is available in most sections if the fire department is too inadequate to utilize it. If they do not have pumping engines to deliver this supply on the fire, if they do not have sufficient or dependable hose, if they lack adequate appliances and equipment to carry out their work, or if they do not have sufficient, properly trained and disciplined men on the force, there can be no expectation of proper utilization of the water system. Therefore, the water superintendent must lend all possible support towards necessary fire department improvements just as much as he would to

projects of his own. This will be coöperation with the fire department in the truest sense, for the common aim of attaining better fire protection. Similarly, projects for fire alarm, a new building code or revisions of the present one or for fire prevention ordinances should be boosted as much as possible; they are all necessary for balanced fire protection.

There is no town too small to have a brief building code; it will gradually reduce the fire hazard of the entire community and may prove of great benefit to you, individually, in case your neighbor gets the idea of throwing up some fire trap of a large building adjacent to your property. The smaller towns may feel no need for a fire prevention ordinance, having but very few if any of the hazards involved within their limits. Such a feeling is incorrect; such hazards should either be suitably regulated or prohibited entirely within the limits in any town. Proper enforcement of such ordinances is often a problem, but can usually be taken care of by the chief of the fire department without placing an undue burden upon him.

CONCLUSIONS

In conclusion, let us emphasize some of the more important things which may be done to provide better fire protection in the smaller communities. Note that we say *better* protection, not *ideal* protection. We have made no attempt to specify additions and changes which would bring these smaller communities *to* the ideal, only *towards* it as much as can reasonably be expected. Such improvements consist first of making very sure that the entire existing system is functioning as perfectly as possible. Then increase storage to meet fire demands; such storage to be elevated preferably, but, if this be impossible, to be at least provided as suction storage supply for a fire pump. Every effort should be made to provide more than one pump, even in the smallest communities, and to provide some duplicate source of power. Be sure that the distribution system is sufficient to take care of the supply you have provided, and take care of reliability by suitable valving and looping of feeder mains. Then set up an annual program, and stick to it, for the gradual elimination of the more minor individual weaknesses, such as dead ends, 4-inch pipe in important sections, wide valve spacings, wide gaps between hydrants and hydrants of obsolete, inadequate or unreliable type, and, above all, take immediate steps to assure that the value of these improvements is not rapidly dissipated through lack of proper main-

tenance. Give your coworker, the fire chief, all the support you can when he asks for improvements so that his facilities may keep reasonable pace with the development of your own. Any of these proposals will be a step towards the goal, and when most of them are carried out you may feel well on your way towards that goal of better and more effective fire protection.

(*Presented before the Indiana Section meeting, April 9, 1936.*)

COLLECTING THE MONEY WITH THE MINIMUM OF FRICTION

A Committee Report

The purpose of this paper will not be to offer a panacea to water companies for collecting all accounts without any friction. Desirable as that may be, it is idealistic and not an attainable reality. As a matter of fact, it may not be a good idea to "get the last dollar." In preparing this paper your Committee has divided it into two sections. The first part deals with the larger problem, including deposits and customer contact; the second part presents the collection procedure which is being followed with good results by one of the member companies of this section of the American Water Works Association.

It is the intention of this Committee to look first of all at the problem in its broader aspects and particularly from the standpoint of public impression and public relation. Far be it for this Committee to infer that the water company executives have not given this matter of public esteem careful thought. Nevertheless, this is a good time to review all credit and collection items that affect the public and to give them critical thought, with a view toward improving our position with our customers.

CREDITS AND COLLECTIONS

We are assuming that credits and collections are handled in the same department or are so related in actual operation that the same purpose is served. The two are closely allied and inter-related, and both, through their very vital contacts with the public, contribute in a large measure to the portrait of the company which is being painted in the mind of the public.

It is common knowledge that we, as a public utility, are different from other businesses in that we have a monopoly, although it is decidedly controlled. When an applicant applies for service he does not have the choice of doing business with a competitor and, therefore, must accept the company's terms even though they may not

be agreeable to him. Customers have a choice as to the retail store or grocery where they may wish to place their patronage, but they do not have this same option when applying for water service. It is most natural, therefore, for this condition to create certain reservation, if not prejudice, in the customer's mind.

In order to overcome this to some extent, a public utility should strive to get its employees, and particularly those who contact the public, to assume the mental attitude that there is a "competitor company" directly across the street. Attitudes are important in any credit and collection department, coming in contact as it does with the customer from the very moment he requests service. There is an old adage, "First impressions are lasting." Is the first impression created in the mind of a customer when he is applying for water service the kind of an impression that we should like to have him carry during the entire time he is a customer?

Let us examine the general practice, based upon a study made by your Committee, of dealing with a prospective customer coming into the office or calling on the telephone requesting water service. Generally, the practice is to have him sign an application form and to determine whether or not he is a property owner. Most companies exempt a property owner from making a deposit unless previous experience has proved him to be a poor credit risk. The balance, not property owners, but who constitute the majority of the customers, are asked either to make a cash deposit or secure a guarantor.

Let us compare this with the same customer's first contact with a high class department store where he is requesting a credit account. The company interviewer has been highly trained in a proper approach and contact with the customer. He obtains certain credit information, such as where the prospective customer is employed, where he does his banking and where he has other accounts. He also takes into consideration the section of the town in which the customer is living. The department store credit department will also avail itself of information which may be available through a recognized local credit bureau. On the basis of such complete information, the average customer will be given the opportunity to open a credit account, the amount of which usually exceeds the amount of his water utility bill by several times.

Your Committee obtained data from various utility companies—water, gas and electric—from various parts of the country, and submits the result of its findings and thoughts for your consideration.

Deposits

Why should not the credit department of a public utility use tactics similar to those used by the department store, and upon the basis of the facts obtained make a distinction between those customers from whom a deposit will be necessary to secure credit and those from whom a deposit is unnecessary. The majority of people are inherently honest, which simplifies the task of making the distinction. Each day there are customers being connected to the lines of water utility companies whose credit is so good that it is almost an affront to require them to make deposits. We do not believe the average customer would resent giving the utility company the credit information which would be necessary to decide whether or not his account should be secured by a deposit. Even the most rabid critic does not question the necessity for credit approval even though he may insist that his credit virtues are such that references are unnecessary. It is interesting to note that about 30 percent of the utility companies contacted followed this plan. From the reports reviewed, there seemed to be a growing feeling that the elimination of deposits, except in the case of transients, poor pay customers, etc., would not increase bad debts more than the amount that would be saved in interest payments, clerical help and the value of improved customer good will.

Naturally, the first question coming into the mind of utility men as they ponder this matter of "distinguishing" between customers' credit rating is the overworked term "discrimination." In the mind of the Committee there is a vast difference between "discriminating" against customers and "distinguishing" between customers. If the same general credit information is requested from all customers and if good, sound judgment is applied in interpreting the data, it is doubtful whether there can be any reasonable charge of discrimination made against us for following this practice.

Under such a plan for determining whether or not a customer is to make a deposit there should be sufficient flexibility to provide for changes in the credit status of a customer. If the customer's credit rating at the time of connection did not require a deposit, but he later develops into the "poor pay" class, proper action should be taken. He may be offered one of two alternatives; first, pay his bills more promptly, which would eliminate the necessity of his making a deposit; or, second, make a deposit to secure the account because of his unsatisfactory payment record. Conversely, a deposit customer

may improve his credit rating enough so that a deposit is considered unnecessary. Arrangements could then be made to refund his deposit with interest.

There are water companies today with a deposit policy under which customers with deposits have no possibility of obtaining a refund until they discontinue the use of the service. Even though the sting of this may be somewhat lessened if interest accruing on the deposit was paid voluntarily by the utility company, at regular intervals, the Committee still feels that the psychological effect upon the customer of a "permanent" deposit is not good.

There is another alternative which the Committee has also considered and which is in effect in some companies. Under this plan the customer is required to make a deposit at the time service is requested. However, the understanding at that time is that this deposit will be held for a specified length of time, after which the customer's account will be reviewed. If the account at that time reflects a desirable condition, the deposit plus interest will be refunded. Without question, a most cordial feeling toward the company is created in the customer's mind when he receives the check for the amount of the deposit and interest with a carefully worded letter suitable to the occasion.

Any utility company which has been requiring deposits from all or a majority of customers and later adopts one of the plans outlined above would immediately be faced with the problem of requiring a considerable sum of money for deposit refunding purposes. Companies having this money in a separate account, and intact, do not have such a large problem. In the case of others, where a strain might be placed upon the treasury, arrangements could be made to stagger the initial refunding over a reasonable period of time.

Immediately upon considering either of the above plans, the accusation will be made that "delinquent and uncollectible accounts will increase considerably." While this may appear so upon first thought, the gross increase in these accounts is not the entire answer. From this increased figure must be deducted, first, the interest that is now being accrued or paid on the large percentage of deposits, and, secondly, the cost of handling customers' deposits records.

While it is obvious that there would be some increase in the charge to uncollectible reserves under either of these plans, your Committee wants to leave the thought, "Would not this increased loss really be money well invested?" While the figures themselves do not tell the

whole story, of those utilities contributing to the survey, the average percent of bad debts charged off annually was no greater in the companies with a liberal deposit policy than in those companies with a strict deposit policy. There was one rather unusual case. Before requiring deposits, less than six years ago, the yearly loss was reported by that company as 4 percent of the gross revenue, while last year it was less than one-half of one percent. But the change in deposit policy came with a change in the management and we inferred from the report made by this company that an improved collection plan was largely responsible for the decrease in bad debts charged off.

Under any plan of requiring a minimum of deposits it is highly important that the credit and collection department more than ever be "on its toes." This is necessary in order to keep delinquent accounts at a minimum. If these accounts are closely watched and deposits are secured where it is felt to be necessary, the deposits will assist in keeping the bad debts to a reasonable figure. One of the requirements of the management is that the charge to uncollectible reserves be held to a reasonable figure so as not to affect adversely the rate which is being charged to all customers. It is unfair to penalize the customer in the "good pay" class to benefit those in the "poor pay class." As far as practical, each class should stand on its own feet, hence the necessity of securing a deposit from the slow and poor paying class. This is a factor with which the Public Service Commission, with its jurisdiction over rates, would also be concerned.

In the questionnaire sent out, opinion was requested regarding the "Guarantor's Agreement" Form of security on accounts. The answers were overwhelmingly opposed to this form of security. Anyone in the business knows the reasons. The presentation of a utility bill to a guarantor is always unexpected and most unwelcome. The exercise of our right to collect from the guarantor is resented by him regardless of the fact that he is legally and morally responsible. The guarantor agreement plan is a breeder of ill-will.

It is gratifying to see that some utility executives are taking cognizance of the lowly deposit and are already voicing themselves on this subject. From the President and General Manager of one company we hear the following:

"Then there is the question of our requiring a deposit in advance to guarantee the payment of domestic gas bills. Preliminary investigation of the cost of handling consumers' deposits indicates that the increased loss, which might be expected if such deposits were waived from domestic consumers,

would be only slightly in excess of the cost of this whole deposit business. If it were found practicable to waive the requirement of a deposit from domestic consumers, the gain in public esteem would be great."

As far as the actual collection of delinquent accounts is concerned, the public has been educated to accept the fact that credit is a vitally essential convenience and that collections are indisputable rights of creditors. Too much attention cannot be given to provide thoughtful and well directed effort in the collection of accounts. The ideal situation appears to include a liberal but sound credit policy, backed by an efficient but considerate collection routine.

Delinquent accounts

Unlike wine, which improves with age, delinquent accounts deteriorate rapidly with time. It is important, therefore, that the collection routine in effect provides for taking immediate action when accounts become delinquent. Customers have more respect for companies which use firm but fair business-like tactics in dealing with delinquent customers as opposed to those who follow loose methods.

During the depression most of the utilities went to the limit with customers who were unable to pay their bills promptly. A certain percentage of these customers have taken advantage of this leniency and never since have resumed the prompt payment of their bills, although financially able to do so. It is the duty of the collection department to re-educate these customers to their responsibility in this matter and to get them to see that it is really less difficult to pay the utility bill each month than to let them accumulate.

Some companies are following the practice of turning over their delinquent accounts to an outside collection agency. On the basis of your Committee's survey only about 10 percent of the companies are following this practice. While the committee members are not in entire agreement on this subject, it is the majority opinion that it is not a good general practice. The tactics of outside collection agencies are sometimes questionable, to say the least. While it may be argued that customers falling in this class may be "no good," it is felt that the individual water company and the industry in general cannot afford to incur any more ill-will than is absolutely necessary, even with this class of customer. Certainly, by using its own employees the utility company can better control the tactics to be followed in dealing with this class of customer.

PROCEDURE USED BY ONE COMPANY

The second part of this Report will outline the collection procedure now being followed by one water company. In order that you may have the background for what is to follow, we will tell you that this company has a five dollar ($5.00) residence deposit policy with an average monthly residence bill of $1.25. Your Committee, while not unanimously endorsing it, decided to present this concrete plan because it is obtaining good results in collecting the money in this company.

This company accepts a great many guarantors instead of obtaining a deposit in each case. In accepting a guarantor, who must be a property owner, care is exercised by the employee accepting the agreement to see that the guarantor has not defaulted on a former agreement, and that he has not been shut off for non-payment of his own bills. In the event it is found that the guarantor has defaulted before, he is not accepted and the customer is notified either to make a cash deposit on his account or to secure another guarantor, subject to acceptance by the company. When the company accepts a guarantor, a notice is sent to the guarantor, advising him of the acceptance of his signature as security on the account. By sending out this notice quite a few forgeries are detected and it also fully acquaints the guarantor with the terms of his agreement.

Naturally, commercial and industrial accounts carry heavier deposits, although deposits are not required from recognized firms, or those who have established a satisfactory credit rating. Commercial and industrial accounts are checked more closely than residence accounts.

Property owners, unless experience has proved them to be poor pay, are not required to make deposits. However, in accepting a contract, when the customer claims ownership of property in a questionable section of town—by this is meant where there is a large percentage of non-payments—the customer's claim of ownership is checked against public records. In the event it is found that he does not own the property, action will be taken either to secure a cash deposit or some other form of security.

Obviously a different procedure is followed in handling current accounts as compared with final accounts. Current accounts, in the collection procedure, are divided into two groups. Group I includes apartment buildings, rooming houses, hotels and private residences. Group II consists of commercial and industrial accounts.

A turn-off order is not issued on Group I until the customer has received four monthly bills. Neither is it the policy to execute a turn-off order until a customer's deposit has been completely exhausted. There have been many adverse rulings by public service commissioners throughout the country when service was discontinued for non-payment and the customer still had a balance on his deposit over and above the amount of the bill.

After the customer in Group I (domestic accounts) has received four monthly bills, and they remain unpaid, the first delinquent notice is mailed seven days after the mailing of the fourth bill. In case of continued non-payment, the final delinquent notice is mailed seven days after the mailing of the first delinquent notice and a turn-off order is executed five days after the final notice is mailed. In Group II (commercial and industrial accounts) the service is usually allowed to run until the customer has received three monthly bills, when the same procedure is followed as in the case of domestic accounts.

It will be admitted that this is a liberal policy. The committee feels that a properly worded delinquent notice should go out to customers before four months elapse. The Committee recognizes the small loss sustained by this company, but at the same time feels the company is not meeting its full responsibility in educating the public to meet its obligations promptly rather than to encourage laxity. It might be added here that this company, as a result of committee discussions, is studying this matter at the present time.

The procedure followed by this company on final accounts (accounts which have been discontinued for non-payment or where the customer has moved to another location), is as follows: Twenty-one days after service is discontinued and the final bill is rendered, a gentle reminder notice of the unpaid account is sent to the customer. These letters are sent out after the accounts are reviewed once each week.

In many cases, this first letter brings results, especially where the final bill has gone astray. It also serves the purpose in many cases of having the customer bring in his deposit receipt, thereby completing a transaction that would eventually have to be done by the company when his deposit would be applied against the account. After the letters are mailed, the accounts are checked against the company records in order to determine whether they are covered by deposits or have guarantors' agreements. This check will also disclose whether any accounts may be transferred to new locations.

When a customer, owing an account to the company, moves from one location to another and when the contract is made for service in the same name, and the evidence is satisfactory that the contracting party is the same person owing the previous account, debits from the first account are transferred to the second and the collection methods used are the same as though the service were continuous at one and the same address.

When a final account has a deposit sufficient to cover the final bill, no additional letter is mailed. Once every three months deposits on these accounts are applied to the unpaid bills. At the time the deposits are applied, a post-card notice is sent to each customer, advising him that his deposit has been applied to his unpaid account and also of any balance due him from his deposit. On the final accounts that the deposits do not cover, a series of three collection, letters is sent out. After this, if no payment has been made and the balance of any account is of sufficient size to warrant a personal call, further effort is made to secure payment. In many of the cases where personal calls are made, the customer has not left a forwarding address. It is the duty of the collector making these calls to find, if possible, where the customer has moved. This is accomplished by inquiries being made in the neighborhood or through a post-office tracer. If, after a reasonable length of time, all routine collection methods are ineffective, these accounts are turned over to an outside collection agency for their handling.

When an unpaid account is secured by a guarantor's form of agreement, and payment is not made within a reasonable time, the customer is notified in writing that unless payment is made within five days after receipt of this letter, his guarantor will be notified of his failure to pay this outstanding obligation. In the event payment is not received within ten days, a notice is sent to the guarantor to the effect that the party for whom he signed as security has neglected to pay his bill. If payment is not received within the next fourteen days, another letter is sent to the guarantor, together with a copy of the bill, requesting him to remit or to see that the debtor makes payment. If this series of letters does not bring about payment of the account, a personal call is made on the debtor to ascertain the reason for his failure to make payment. A very liberal policy is followed in the event the debtor wants to make partial payments to clean up the account. As a last resort, on guaranteed accounts, a personal call is made on the guarantor and his permission is secured if possible

to include the amount of the debtor's bill on his personal account. If the guarantor grants this permission, care is taken to see that the guarantor is not shut off for non-payment unless his own personal account becomes delinquent. In the event permission is not secured from the guarantor to include the debtor's bill on his own personal account, a card is placed in a file so that this party will not be accepted as a guarantor on any other account. This account is then given to an outside collection agency, with instructions that they are to attempt collection from the former customer only and not from the guarantor.

On other accounts, such as agents, owners, etc., which are not secured by deposits or guarantors and it is not possible to transfer the account to a new location, the usual series of three collection letters is mailed in each case. If results are not forthcoming, personal calls are made on the debtors. If payments are not received in a reasonable time, the accounts are turned over to an outside collection agency.

Bad debts are written off every three months. This procedure assists the bookkeeping department by regularly clearing out the older accounts. Final accounts are held on the books only six months before being written off. It is felt that this is sufficient time, in the majority of cases, to either collect the accounts or determine that they are worthless.

Special arrangements for the payment of old delinquent bills are made wherever the circumstances warrant. Frequently a customer wants service restored but owes an old bill. An agreement will be made whereby the customer can pay his current bill in full each month and pay something on account on his old bill.

Before closing this Report, your Committee would like to refer to the proverbial "four hundred list" of poor paying customers who are so well known to those working in utility collection departments. Your Committee wonders whether the various companies are just accepting this list as it stands or whether some effort is being made to get some of these customers to see that it is neither to their best interest nor to the company's to continue in this class. In many instances these customers are paying a collection charge or losing their discount each month, the total of which, in a year's time would pay for one month's bill.

Neither would this Report be complete without reference to the "cut off" list. Every collection department has the inevitable, but

disagreeable, task of discontinuing service in some cases on account of unpaid bills. But every company has had the regrettable experience of cutting someone off who was not worthy of such drastic treatment. One executive has put it most succinctly in these words:

"A responsible employee, given sufficient authority to permit the exercise of individual judgment, should pass finally on every order to shut off a meter for non-payment. The issuing of a final shut-off order should never be permitted to become a routine matter dependent solely upon the expiration of time."

One of the dangers constantly confronting us is that of accepting, and failing occasionally to check, the routine affairs of our business. While they may be only accepted procedures to us, they are in reality the contacts that determine to a large degree the public sentiment toward us. Some of our routines may be in need of revision from time to time in order to keep pace with changing conditions.

And finally, let us not fail to check over the personnel handling this phase of our business. Perhaps some of our present contact people had better be removed to the office proper and away from the public. If a program, patterned somewhat along the lines suggested above, requires a more intelligent and otherwise better qualified personnel in this phase of our business, we cannot make the necessary changes too soon.

Respectfully submitted,

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Committee of the Indiana Section.

(Presented before the Indiana Section meeting, April 8, 1936.)

THE TOKYO WATER-WORKS

By Tomihisa Iwasaki

(City Engineer, Department of Water-works, Tokyo City, Japan)

The Tokyo Municipality supplied 250 million gallons of water a day in the summer of 1935. The fundamental supply project at present is based upon a maximum daily consumption of 200 million gallons. The cost of construction from the beginning up to the present has exceeded $79,000,000; and it is estimated that a total

Fig. 1. Murayama Reservoir

investment of more than $110,000,000 will be needed by the year 1942.

The main sources of water are the Tama River, the Yedo River and some wells. Water is collected by gravity at Hamura, and by pumping at Chofu, Kinuta and Kanamachi. By taking advantage of the topographical features of Sayama district, 3 reservoirs are constructed, impounding the water of 2 valleys by means of 3 earthen dams.

These reservoirs hold in total 7.5 billion gallons of water of the

Tama River, and provide against drought. But in order to replenish the shortage of supply prevailing in winter, one high masonry dam is proposed to be built at Ogochi district to impound the water of the Tama River. A large filter plant is projected at Kanamachi of the Yedo River which will be put into service by the year 1937.

The intake of Hamura is situated about 30 miles from the center of Tokyo to the north-west. The river water is diverted there to flow into an open canal and afterwards through a long tunnel led into the reservoirs. The intake at Kanamachi is situated about 9 miles north-east from the center of city, where the river water is pumped up and supplied to the city after purification.

FIG. 2. SAKAI FILTER PLANT

The average speed of filtration was 11 feet per day, throughout the fiscal year of 1933. The effective filter hours numbered 682 hours, the longest being 1,608 and the shortest 144 hours.

Chlorination was applied to filtered water, as well as to raw water especially when epidemics were prevalent. A solution of copper sulphate was poured into reservoirs to exterminate algae and micro-organisms which would otherwise retard filtration.

The Tokyo Municipality always pays careful attention to the purity of water as the most important problem in water supply. River, stored, filtered and running water from taps are always tested bacteriologically and chemically.

The daily maximum consumption in 1936 and 1937 is supposed to

TABLE 1*

Laboratory tests—raw water—September, 1935

	CENTRAL TOKYO SYSTEM, MURAYAMA, YAMAGUCHI-RESERVOIR	KINUTA SYSTEM, SURFACE WATER OF THE RIVER TAMA		TAMAGAWA SYSTEM, SURFACE WATER OF THE RIVER TAMA AT CHOFU	KANAMACHI SYSTEM, SURFACE WATER OF THE RIVER EDO AT KANAMACHI
		At Kinuta upper	At Kinuta lower		
Number of tests: chemical/bacteriological	12/12	5	5	16/65	4
Atmospheric temperature:					
Maximum		29.3	27.8	30.0	28.0
Minimum		18.6	16.7	20.0	16.5
Mean		21.7	19.9	29.7	21.8
Temperature of water:					
Maximum	24.0	23.3	22.0	23.0	24.0
Minimum	16.0	17.1	16.6	17.5	18.5
Mean	20.8	19.0	18.7	18.8	20.6
Color:					
Maximum	0	0	0	0	40.0
Minimum	0	0	0	0	10.0
Mean	0	0	0	0	21.3
Turbidity:					
Maximum	6.5	160.0	110.0	1000.0	50.0
Minimum	3.0	5.0	4.0	8.0	10.0
Mean	3.8	55.0	41.0	176.2	26.3
Odor and taste	None				
Reaction	Weak alkaline				
Chlorine:					
Maximum	1.773	4.071	4.608	3.546	7.624
Minimum	1.418	2.836	2.863	2.482	5.319
Mean	1.574	3.330	3.763	3.192	6.516
Sulphates	Trace				
Nitrates	Trace to naught	Trace			
Nitrites	None				
Ammonia	None				

* (1) Figures for chlorine, total solid residue, and consumption of potassium permanganate are the weights in milligrams per liter of water.

(2) Hardness of water is indicated by German grade.

(3) In the column of number of testings, the figure before the diagonal line is the number of times for chemical analysis, and the figure after the diagonal line is the number of times of bacteriological testing.

TABLE 1—*Concluded*

	CENTRAL TOKYO SYSTEM, MURATAMA, YAMAGUCHI-RESERVOIR	KINUTA SYSTEM, SURFACE WATER OF THE RIVER TAMA		TAMAGAWA SYSTEM, SURFACE WATER OF THE RIVER TAMA AT CHOFU	KANAMACHI SYSTEM, SURFACE WATER OF THE RIVER EDO AT KANAMACHI
		At Kinuta upper	At Kinuta lower		
Hardness:					
Maximum	1.775	1.525	1.650	1.575	2.576
Minimum	1.575	1.400	1.525	1.000	2.264
Mean	1.679	1.500	1.600	1.392	2.459
Total solid residue:					
Maximum	80.0	87.000	89.000	1305.000	168.000
Minimum	61.0	80.000	87.000	82.000	130.000
Mean	69.5	84.000	88.000	341.375	148.500
Consumption of potassium permanganate:					
Maximum	4.661	4.740	6.004	100.935	7.584
Minimum	1.817	1.422	1.580	2.054	3.476
Mean	2.665	3.033	2.496	20.117	5.570
Bacteria, colonies per cubic centimeter:					
Maximum	4000	1480	1540	3700	5800
Minimum	78	320	350	48	1650
Mean	1351	842	822	451	3188

be more than 290 and 300 million gallons respectively which is about 50 percent over the present standard capacity, 193 million gallons a day. As the draft varies in accordance with temperature, filtering speed should be increased to 14.9 feet a day, which represents a 50 percent increase on the present standard speed of 10 feet a day.

According to the author's experience, the water delivered varies somewhat in proportion to the working pressure, with a rate of 2 percent for each pound per square inch of water pressure. Nearly 6 percent of the daily consumption in this city can be saved by (a) partially closing ordinary main valves, (b) replacing the impellers and guide vanes of pumps, (c) reducing the tap flow by partial opening of the stop cocks, etc.

TABLE 2

Laboratory tests—settling reservoirs—September, 1935

(See key in table 1)

	CENTRAL TOKYO SYSTEM, YODO-BASHI SETTLING RESERVOIR	SUB-SURFACE FLOW, KINUTA		TAMAGAWA		KANAMACHI	
				Slow settling reservoir	Rapid settling reservoir	Slow settling reservoir	Rapid settling reservoir
Number of tests: chemical/bacteriological	8/16	5	5	10/10	5/5	4	3
Atmospheric temperature:							
Maximum		29.3	27.8	30.0	30.0	28.0	26.0
Minimum		18.6	16.7	20.0	20.0	16.5	17.0
Mean		21.9	19.9	20.3	25.3	21.8	22.7
Temperature of water:							
Maximum	23.0	20.0	19.5	24.0	23.0	24.5	23.5
Minimum	17.8	17.4	17.0	18.0	18.5	19.5	19.0
Mean	19.9	18.4	18.2	20.8	20.1	21.6	22.0
Color:							
Maximum	0	0	0	0	0	20.0	0
Minimum	0	0	0	0	0	10.0	0
Mean	0	0	0	0	0	13.8	0
Turbidity:							
Maximum	10.0	7.0	3.5	60.0	12.0	11.0	2.0
Minimum	5.0	0.0	0.0	14.0	4.0	9.0	0.5
Mean	6.6	4.0	1.5	29.3	8.6	10.0	1.3
Odor and taste	None						
Reaction	Weak alkaline			Neutral	Weak acid	Weak alkaline	

Chlorine:							
Maximum	1.773	5.672	9.217	3.901	3.546	7.624	7.979
Minimum	1.418	5.317	6.026	2.837	2.837	5.851	6.028
Mean	1.507	5.545	7.444	3.264	3.334	6.649	7.269
Sulphates	Trace						Very small amount
Nitrates	Trace to naught	Trace					
Nitrites	None						
Ammonia	None						
Hardness:							
Maximum	1.825	2.030	2.550	1.600	1.600	2.576	2.810
Minimum	1.700	1.775	1.775	1.000	1.200	2.290	2.758
Mean	1.743	1.826	2.161	1.408	1.460	2.433	2.793
Total solid residue:							
Maximum	85.0	93.000	110.000	166.000	168.000	122.000	134.000
Minimum	68.0	80.000	86.000	85.000	75.000	108.000	119.000
Mean	76.1	87.000	98.000	107.000	105.200	116.750	126.333
Consumption of potassium permanganate:							
Maximum	2.844	1.106	0.948	4.819	1.422	3.792	1.580
Minimum	1.580	0.948	0.632	1.264	1.185	2.212	1.580
Mean	2.157	1.043	0.853	2.642	1.343	2.963	1.580
Bacteria, colonies per cubic centimeter:							
Maximum	846	135	140	860	19	2200	900
Minimum	144	85	45	75	4	1150	200
Mean	477	117	89	211	9	1738	550

TABLE 3

Laboratory tests—filtered water—September, 1935

(See key in table 1)

	CENTRAL TOKYO SYSTEM		KINUTA		TAMAGAWA		KANAMACHI	
	At Sakai	At Yodobashi	Upper	Lower	By slow filtration	By rapid filtration	By slow filtration	By rapid filtration
Number of tests: chemical/bacteriological	2/4	2/4	43	24	25/80	18/43	70/20	15
Atmospheric temperature:								
Maximum			29.3	27.8	30.0	30.0	28.0	26.0
Minimum			18.6	16.7	20.0	20.0	16.5	17.0
Mean			21.9	19.9	25.4	24.8	21.8	22.7
Temperature of water:								
Maximum	23.2	22.5	21.1	19.6	24.0	23.0	24.5	22.5
Minimum	18.5	17.8	17.4	16.5	18.0	18.0	18.5	19.0
Mean	21.2	20.2	17.8	18.1	19.9	17.6	21.0	21.2
Color:								
Maximum	0	0	0	0	0	0	0	0
Minimum	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0
Turbidity:								
Maximum	0	0	0	0	0	0	0	0
Minimum	0	0	0	0	0	0	0	0
Mean	0	0	0	0	0	0	0	0
Odor and taste	None							
Reaction	Weak alkaline				25	Weak acid 12—6	Weak alkaline	

Chlorine:								
Maximum	1.595	1.418	5.849	8.862	4.255	3.901	7.447	8.156
Minimum	1.418	1.418	4.608	5.672	2.837	2.837	5.674	5.496
Mean	1.507	1.418	5.474	6.770	3.420	3.429	6.507	7.092
Sulphates	Trace				25	Very small amount 2 Trace 16	Trace	
Nitrates	Trace to naught		Trace		Trace 25	Trace 18		
Nitrites	None							
Ammonia	None							
Hardness:								
Maximum	1.775	1.750	1.775	2.550	1.625	1.600	2.628	2.914
Minimum	1.725	1.725	1.525	1.650	1.175	1.250	2.108	2.342
Mean	1.750	1.738	1.722	1.898	1.427	1.490	2.414	2.746
Total solid residue:								
Maximum	64.0	78.0	90.000	112.000	108.000	101.000	108.000	134.000
Minimum	62.0	65.0	74.000	83.000	60.000	64.000	93.000	107.000
Mean	63.0	71.5	80.000	95.000	81.840	79.388	99.150	119.067
Consumption of potassium permanganate:								
Maximum	1.501	0.948	1.106	0.948	1.185	1.106	1.580	1.264
Minimum	1.027	0.711	0.790	0.632	0.632	0.553	0.790	1.106
Mean	1.264	0.830	0.940	0.806	0.954	0.893	1.193	1.190
Bacteria, colonies per cubic centimeter:								
Maximum	14	8	29	36	11	10	48	89
Minimum	6	3	3	2	1	1	4	39
Mean	9	5	12	14	3	2	14	57

TABLE 4

Laboratory tests—tap water—September, 1935

(See key in table 1)

	CENTRAL TOKYO SYSTEM			TAMAGAWA TAP WATER	KANAMACHI TAP WATER
	Tap water	Upper tap water	Lower tap water		
Number of tests: chemical/bacteriological	70/140	28	28	40/100	40
Atmospheric temperature:					
Maximum		26.7	23.7	27.0	31.0
Minimum		16.5	22.0	19.0	19.0
Mean		20.8	22.8	23.9	23.4
Temperature of water:					
Maximum	24.8	21.9	20.5	23.0	26.0
Minimum	17.0	18.0	18.3	18.5	18.5
Mean	21.5	19.8	19.3	20.4	21.8
Color:					
Maximum	0	0	0	0	0
Minimum	0	0	0	0	0
Mean	0	0	0	0	0
Turbidity:					
Maximum	0	0	0	0	0
Minimum	0	0	0	0	0
Mean	0	0	0	0	0
Odor and taste	None				
Reaction	Weak alkaline				
Chlorine:					
Maximum	1.773	5.672	7.976	3.901	7.624
Minimum	1.418	4.071	5.672	3.191	5.851
Mean	1.606	5.157	6.590	3.546	6.587
Sulphates	Trace				
Nitrates	Trace to naught	Trace			
Nitrites	None				
Ammonia	None				
Hardness:					
Maximum	1.800	1.775	2.290	1.775	2.940
Minimum	1.650	1.650	1.775	1.425	2.238
Mean	1.758	1.744	2.031	1.580	2.592
Total solid residue:					
Maximum	83.0	87.000	110.000	96.000	140.000
Minimum	50.0	74.000	88.000	62.000	95.000
Mean	69.3	81.000	97.000	75.750	111.525

TABLE 4—*Concluded*

	CENTRAL TOKYO SYSTEM			TAMAGAWA TAP WATER	KANAMACHI TAP WATER
	Tap water	Upper tap water	Lower tap water		
Consumption of potassium permanganate:					
Maximum	1.185	0.948	1.106	1.185	1.264
Minimum	0.474	0.790	0.632	0.948	0.790
Mean	0.744	0.897	0.846	1.037	1.142
Bacteria, colonies per cubic centimeter:					
Maximum	73	27	27	21	29
Minimum	1	4	1	1	4
Mean	10	10	9	4	10

THE LUBRICATION OF WATER WORKS EQUIPMENT

By W. B. Phillips

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Lubrication plays the same singular rôle in water works systems that it plays in industrial plants. It performs an obscure function when filling its rôle properly, but it becomes the focus of irate attention when it fails. It has also always been the tendency to minimize the importance of lubrication because of its insignificant cost compared to total operating cost. However, if *friction*, the thief of power and giant of destruction, be shackled only by the variable strength of a film of oil, it well behooves every plant engineer, every operator of mechanical equipment, to protect his peace of mind and his company's investment with the largest possible factor of safety, by careful and intelligent selection and application of lubricants.

TYPES OF LUBRICATION

Rather than catalog plant equipment in a paper of restricted length, we prefer to classify common types of conditions. The reservoir type ring oiled bearing, commonly found on electric motors, centrifugal pumps, engine journals, etc., is, by far, the most common. Oils in this service are used over and over again and they must successfully resist the degrading effect of exposure to dust and dirt, air, heat, and this water formed in the natural "sweating" of any bearing. Conditions of this kind impose a severe duty on lubricating oils, and all of you are familiar with the brown jelly-like muck, generally called "sludge," which forms when ordinary oils are used. For satisfactory service under these conditions, quality oils with turbine oil qualifications should be used, and although their initial price may be somewhat above that of so-called red engine oils, their dependability over a long period of time will justify their use. We advocate a regular schedule for changing oil in these bearings, at which times bearings should be drained, thoroughly flushed—first with kerosene, then with new oil—before they are refilled. Normally, semi-annual changing is sufficient; however, local conditions sometimes make it advisable to change oil more often.

Where bearings are fed by a circulation system, either pressure or gravity, the same high quality is essential. When the oil is used, however, only once in a plain bearing which is wick fed, bottle or hand oiled, a red engine oil of the proper viscosity or body will suffice. Normal conditions of speed, temperature and pressure for bearings of these types dictate the use of medium to heavy medium viscosity oils —possibly between 42 and 55 seconds viscosity at 210°F.—with the slower speeds and heavier pressures requiring the higher viscosities mentioned.

Although the manner in which bearings are poured, journals turned, and oil grooves put in babbitt bearings, are machine shop practices, and outside the scope of this paper, the utmost care must be taken in this respect, particularly with regard to grooving.

Should equipment of this type employ grease roller or lubricated ball bearings, the selection of a grease would depend largely on operating temperatures, pressure and the degree of moisture encountered. Anti-friction bearing greases comprise two general classifications, first, the smooth, buttery, lime soap greases which resist the effect of water, but which have low melting points and cannot withstand temperatures much over 110°F. and the other type being soda soap greases characterized by spongy, fibrous appearance, high melting points, superior performance under centrifugal force, but with the unfortunate weakness that they emulsify into a lather when agitated in the presence of moisture. The condition of moisture presence, however, is generally avoided in machine design, consequently because of their other advantages, soda soap greases are used in the vast majority of anti-friction bearing installations. Greases, incidentally, are no better than the oils they contain or the skill of the grease manufacturer, but even with the best grease, thoroughly neutral and containing no filler of graphite, talc, pumice, etc., watch out for the application! More anti-friction bearings have been lost by over-lubrication than under-lubrication. Pack your ball and roller bearings about one quarter to one-third full of grease for free, easy rolling friction and best results. When bearings are packed full, balls and rollers are so congested with grease that they may slide instead of turn. One good slide and you wear a flat spot, one good flat spot and you buy a new bearing, because the seriousness of any imperfection in balls, rollers or races is progressive, and break-down is imminent. The total cost of replacing any bearing, plain, fancy or anti-friction, will buy a lot of grease and oil. Where possible, we recommend a

definite schedule for changing grease in anti-friction bearings. At this time the bearings should be taken out, thoroughly cleaned of dirt, grit and foreign matter, carefully repacked by hand and replaced. This is seldom necessary more than twice a year and we recommend taking the bearings out because cleaning is extremely important and because it is difficult to judge the proper amount of grease to feed through a pressure fitting.

Lubricating steam equipment

Where steam engines and steam pumps are still employed, the factors qualifying lubricant selection are the condition of the steam, the piston speed, the disposition of the exhaust steam and the method of introducing oil into the steam line. As complicated as these factors may seem (and they really are even more complicated) we may simply say here that a saturated or wet steam condition requires the use of a cylinder oil compounded with from 5 to 10 percent of a fixed oil, such as lard, tallow, or degras, which admixture renders the compound saponifiable in the presence of moisture which provides a soapy, protective film to the cylinder wall surface. Where superheated steam is provided, straight mineral oils may be used with impunity. They offer no advantage, however, over the compounded oils except that they are more readily separated from exhaust steam or condensate in the event that either is used for heating or recirculation. I mention the introduction of oil into the steam line as a factor because the proper atomization of cylinder oil in steam is of utmost importance. For best results, oil must be introduced below the separator and, if possible, approximately six feet above the steam cylinder. The best atomization is secured by drilling the steam line at this point, inserting a nipple to slightly beyond the center of the line, the nipple having been cut into the form of a quill. It is obvious that as the drops of oil flow into this quill, the velocity of the steam in the line will force the oil through the slit, atomizing it perfectly. The crank and main bearings, whether lubricated by circulation system or by hand, have been covered previously and, of course, the valve gear, and guides offer no problem. Where splash systems are found, definite qualities are again required to prevent emulsification with moisture, or oxidation and consequent sludge. For dependable service a very light oil of turbine quality is the usual recommendation.

Diesel engine lubrication

More and more we find the Diesel engine in use for power generation and water pumping. The lubrication of Diesels is a text in itself, but briefly, cylinder walls offer a condition of low pressures, high speed and intense heat. Wrist pins have high pressures and temperatures with comparatively high speeds. Unfortunately, only one oil can be used, although some of the larger Diesels have separate systems for cylinders and bearings. Consequently, we have to compromise, and to serve these various conditions satisfactorily, Diesel lubricating oil has to be good. The oil selected must give a tough, protective film on hot cylinder wall temperatures, but it must not form carbonaceous deposits which stick rings and clog exhaust ports. Where crank case oils are used, again excellence in resisting oxidation and sludge formation afford dependable lubrication for crank and main bearings. Common opinion has it that Diesels burn anything. To the contrary, Diesel engines vary greatly in efficiency, depending upon fuel adaptability, and in a great many cases troubles which appear to be faulty lubrication, can be traced to unsatisfactory fuels.

Lubricating gasoline engines

Gasoline engines, both two and four cycle, are often used in connection with water systems, and in both cases it is imperative that quality oils be used. The manufacturers of four cycle engines generally specify the S.A.E. number or body of the oil to be used. To secure maximum performance, however, the oil selected must resist oxidation and sludge, form a minimum of carbon, pump freely at low temperatures, give good piston seal for full power, and rich fluid lubrication to all working parts. Two cycle engines are generally lubricated by mixing the lubricant with the gasoline. It is, of course, important that a proper mixture be used and that the gasoline and oil be well mixed in a container before being put into the gasoline tank. Mixtures in use average one pint of lubricating oil per gallon of gasoline; however, they vary greatly with different installations.

Ordinarily, a satisfactory oil for Diesel cylinder lubrication will give excellent performance in air compressors, although air compressor oils may be somewhat lighter in body, particularly on single stage units. Air compressor cylinder lubrication also requires an oil with a rich protective film, but at the same time one which will burn clean and have the least tendency to form carbon. A word of caution

to air compressor operators: follow the recommendation of the manufacturers as to the number of drops of oil per minute to be used for best performance. For average units, between two and five drops per minute are sufficient. Any excess may possibly clog the exhaust valves with carbon or carry over into the compressed air tank.

Pneumatic Tools

The correct lubrication of pneumatic tools such as paving breakers, jack hammers and other drills will definitely result in increased tool life, more efficient, more lively and harder hitting pistons, and reduced air consumption. In general, oil is applied to these tools by one or a combination of two or three methods: (a) hand oiling; (b) pulsation oiler; (c) air line oiler. Hand oiling is, of course, the most common method, in which case the oil or semi-fluid grease is poured directly into the air hose connection to the tool. This is obviously very inefficient and wasteful, because much more lubricant than is required is used at first and the tool is starved before the next charge is applied. Most operators frequently forget to oil again until the tool slows down or binds because of high metallic friction. Naturally, care should be taken to prevent this. Simple oil cups are available to improve hand oiling, in that a measured amount of oil can be introduced into the tool at any time. It does not, however, eliminate the necessity of the operator oiling at required intervals. Pulsation oilers are recommended as being very satisfactory and provide ample lubrication so long as all air and oil ducts leading to and from the oil chamber are kept open and not permitted to become clogged with dirt. Air line oilers are very efficient for this type service and require less care, inasmuch as its oil capacity is generally sufficient to permit a full day's work between fills, and it requires no attention except an occasional thorough cleaning. Obviously the lubricant used must be such that it will flow freely at low temperatures, spread uniformly over all contact surfaces and under high temperatures still provide a tough, adhesive oil film that will prevent metal to metal contact of the rubbing surfaces. Oils for this service are always heavily compounded, usually with rape seed oil, so that they will not be washed from metallic surfaces by the moisture that is unavoidable in compressed air.

In presenting this paper we have been forced to talk in generalities as every piece of mechanical equipment offers its own particular problem, and we believe you understand that because of these mani-

fold factors involving lubrication recommendations, we can set no hard and fast rules. We urge you to consider, however, that lubrication costs are a negligible fraction of the total operating cost of any water works. In full realization of the fact that the performance of thousands of dollars worth of equipment, and the hazards of interrupted service, rest on a thin film of oil, we are confident you recognize that there is no substitute for quality.

All major oil companies and any number of compounding and blending companies have lubrication engineers who are thoroughly qualified to make complete surveys of the equipment in use at any plant. Any of these companies will be pleased to provide this service and to supply you with their written lubrication recommendations for your equipment and to discuss thoroughly your various lubrication problems.

With this specific recommendation of lubricants for your plant, adopt a definite schedule of lubrication, and where this procedure is followed—although you may find your cost per gallon higher—your ultimate cost for lubrication will be less. You may feel secure in the knowledge that the tremendous investment involved in mechanical equipment in your plant, is securing the maximum protection by correct lubrication.

DISCUSSION

E. H. HERBERT (Superintendent, of Pumping Stations, Norfolk, Va.): Mr. Phillips very correctly insists that, while lubrication performs an obscure function when filling its rôle properly, it becomes a veritable boomerang when it fails, completely upsetting the most efficiently operated plant in a short space of time.

Since the lubrication of various types of machinery has already been thoroughly classified, it is not necessary at this time to discuss the details with which you are already familiar. I cannot, however, impress too strongly upon you the fact that good lubrication is the most important feature of operation. In the past, unfortunately, this fact seems to have been constantly overlooked by manufacturers, but I am glad to say manufacturers throughout the world are daily becoming more enlightened upon this subject and beginning to realize the great inportance of thorough lubrication.

As an example of the above statement, in 1921, a fifteen million Horizontal Cross Compound Snow Holly Pumping Engine was installed in the Moores Bridge Water Works Pumping Station, at

Norfolk, Virginia. This pump was orginally equipped with the ordinary brass threaded grease cups. The oiler, or engineer, after filling these cups with the proper grease, would give the grease cup cap a turn-or-two about every hour, in order to lubricate the bearings. Sometimes the caps would be cross threaded, or the oiler's hands, being greasy, would slip on the cap, thereby causing the bearings to become dry and to wear by excess friction. This condition would continue without detection until a squeaky noise emanated from the dry bearing, crying for lubrication. This neglect, as you know, would eventually necessitate the replacement of this particular bearing, in some instances, at great cost. After a year's service all grease cups on this engine were replaced with Alemite Pushtype Fittings, which are used with a hand compresser. A portable grease storage tank of about twenty-five pounds capacity is filled from a four hundred pound grease pump attached to the portable tank. By this method the grease is protected from dust, grit, or any other foreign matter. The bearings are then greased with the hand compressor which forces the grease through the fittings to the bearings at about two hundred pounds pressure, thus assuring thorough lubrication for every bearing. As proof that this sytem is foolproof and reliable, the above mentioned pumping engine has been in continuous operation for fifteen years without a bearing being replaced.

The above is also a much more economical method of greasing, inasmuch as not only is grease saved, but, about fifty per cent more of the oiler's time is available for other duties.

In my experience, a cheap grade of red engine oil, certainly in most cases, is the most expensive form of lubrication. For instance, a circulating, gravity feed, oiling system was installed on the above mentioned pump. When the cheap oil was used the entire system had to be cleaned, the oil discarded and replaced by new oil every one or two months. After trying a high grade oil, of about turbine qualities, the oil could be used over and over again with good results and that the oiling system would not have to be cleaned, or the oil replaced, until after six or eight months continuous service.

Although the high grade oil's initial cost is about thirty per cent higher than the cheaper oil, an actual saving of fifty per cent was shown on engine oil in one year's operation.

Mr. Phillips is absolutely correct as to over-lubrication of anti-friction bearings, such as ball or roller bearings, especially if they are lubricated with grease. More of these bearings are ruined by packing

them too full, rather than underpacking. Most engineers get into the habit of putting in more grease instead of taking out the old grease that has been used for months and has absorbed moisture, accumulated sludge, and become full of hard spots, when all that is necessary is a thorough cleaning of the bearings and replacement with new grease. This is a most important point and cannot be too strongly emphasized.

In these modern times, with competition high, there is really no excuse for any one failing to have proper lubricant for any special equipment, as each of the standard companies dealing in oil today is glad to place at our disposal, without cost, thoroughly trained lubrication engineers to test machines and to recommend the proper kind of lubricant necessary for safe and economical operation, when interesting, practical, and thoroughly comprehensive literature dealing with this all important subject can be had for the asking, and when bodies, such as this, meet together from all parts of the country, for friendly discussions of problems relating to plant operation and equipment.

(*Presented before the Virginia Section meeting, November 8, 1935*)

LOCATION RECORDS OF MAINS AND SERVICES

By W. K. Van Zandt

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Accurate recorded information of water mains and appurtenances which is of such a nature as to serve adequately the several requirements of both office and field is properly termed "Location Records." Although these "tools" are required daily in all phases of operation, it is surprising how few water departments, in both large cities and towns have records which will conform to these specifications.

The superintendent and the assistant superintendent in a town might attempt to remember the many details of their system and operate it to some degree of satisfaction. However, when the system expands to such an extent as to include a hundred miles or more of mains, it is absurd to consider that two men might remember the many locations and numerous other details of the mains and services. When one person in any water works is the sole custodian of records for even a small section of mains, it is quite a problem of human nature to prevent jealousy. Furthermore, such a person might be replaced through death or discharge, and a gap, that is usually not only slow but very expensive to fill, is thus opened in all operations. There have been many cases where superintendents or foremen have had small sets of records, which served the purposes in a more or less satisfactory manner and which records they termed "personal." These employees either destroyed or removed the records from their files when they were replaced. Such folly surely adds heavily to the difficulties of the incoming superintendent.

Although the general discussion in this paper is relative to systems in cities of 100,000 or more population, it might be modified proportionately for smaller cities.

Records are in hourly demand in maintenance work, general office operations, planning of improvements, and construction work. Uneconomical maintenance work always results when records are incomplete. In this respect, one will find many extra size paving cuts, unnecessary excavations, and delays in making shut-offs. The proper spacing of valves is not of any value unless the crew foreman

has at his disposal in the field, records showing the exact locations of all valves. Applicants for new service connections cannot be supplied with the correct information if office records are not up-to-date. Such a condition surely is not a bearer of good will as many prospective customers quite naturally assume this to be an index of the general operations of the department. Employees cannot be expected to handle service complaints properly if the records are not dependable. If future improvements are to be made in the most economical manner, then the details of the existing system must be carefully considered. Such review is impossible if the designer must rely on his imagination in preference to records. Force accounts on construction jobs reach unusual proportions when existing properties are incorrectly shown on the plans and extra excavation is necessary in order to locate mains for connection purposes. Frequently, an excavating machine rips out an unknown service line or main and results in both damage to water department property and pipe trench.

The general plan of a system of records should receive very careful attention. It is not frequent that one is called upon to devise a completely new system; however, minor revisions of an existing system are usually found to be more intricate. The desired objective is a system that will fill both office and field requirements with a minimum duplication of information.

A suggested set of records would consist of an office wall map (of scale $1'' = 500'$ to $1'' = 1000'$), a set of section drawings (of approximate size $30'' \times 36''$ and to scale $1'' = 100'$) and a set of street intersection drawings (of size $8\frac{1}{2}'' \times 11''$ and to the scale $1'' = 20'$) together with the necessary cross-index maps. Drawings, with both plan and profile views, should be prepared prior to laying 4 inch and larger mains. Such drawings, if revised following construction and whenever changes are made, will provide a complete record for the larger mains.

A set of line conventions for appurtenances and mains should be employed. The standard conventions as recommended by the National Board of Fire Underwriters should be adopted whenever one prepares a new set of maps. A cloth wall map of the city showing the street locations of 4 inch and larger mains, fire hydrants, elevated tanks, and pumping stations is in a suitable form when it is of the roller type, with good illumination, and protected from dust, finger prints, and pencil marks by a sealed case with a glass front. The section drawings should be drawn with ink on a good grade of tracing

cloth with all mains shown to scale only. The undimensioned location of service lines should be included on these maps. In this way, the number of the field order would be indicated for each service line. The exact connection details could be secured by consulting the file containing the original order and sketch. Such information may be furnished to the field via telephone.

Blueprints of intersection drawings, the originals being inked tracings, should be numbered and bound as books, in accordance with their respective section map numbers. The initial sheet should be the respective section skeleton map. Details, dimensions, and description of mains and appurtenances should be clearly indicated. Ties should be made to permanent or semi-permanent physical features (curbs, sidewalks, etc.) and each referenced to the approximate property line (for ease in transferring information to section maps). The ties are to be made "completely around" the intersection and thus the changing of physical properties at several points of the intersection will not void the drawing. A street intersection drawing, of approximate scale $1'' = 500'$, will give a small skeleton map of the complete section with valves and fire hydrants indicated as well as the key number for each intersection drawing. Good lettering and neatness will add much to the drawings. Repair trucks equipped with a complete set of intersection maps for the division will find it necessary to consult the office at infrequent intervals.

Just prior to backfilling the ditch of a section of new mains, complete and detail intersection sketches of pipe and appurtenances should be made. If appurtenances have been connected at intermediate points or should the alignment of pipes be irregular between intersections, the sketches should be enlarged so as to include these details. Invaluable information may be secured by requiring the crew foreman to tie in the location of the main and the cover of same whenever a main is uncovered. A simple sketch on the back of the work order card will suffice, both for this case and that of the new service installation. Information for records may be secured by use of wireless pipe locators and dipping needles. In the past three years, a number of cities added much data to their incomplete records with pipe location crews consisting of relief labor, except supervisory, using the devices just mentioned.

Only up-to-date records may be considered satisfactory. The maintenance of a record system for a large department is a daily task for engineer, superintendent, and their assistants.

(*Presented before the Southwest Section meeting, October 16, 1935.*)

WATER DEPARTMENT BUDGETS

By T. G. Banks

(Superintendent and Engineer, Water Department, Oklahoma City, Okla.)

Webster's dictionary states that "budget" is of French origin being the diminutive of "boge," "bouge," "leather bag," from the Latin "bulga." It also refers to budget as the annual statement which the British Chancellor of the Exchequer submits in behalf of the ministers to the House of Commons for approval.

From this origin, the term budget as applied to water departments, to the statements of their proposed expenditures, as submitted for the approval of the governing bodies of the community, is aptly named.

The most important condition entering into the discussion of budget preparation is the organization of the water department. If it be on the basis of a utility, with a water board as managing agency separate and apart from the municipal government, that fact will have a material effect upon all of its operations, and consequently upon the preparation of the budget. Thus, independent of governmental functions, it may take advantage of all of its own resources, or, if you prefer, it may be left to its own resources. Such a separation may even extend to the point where the department is subject to the corporation regulatory bodies of the State.

Between the two extremes, most of us at times appreciate the protective shield afforded by municipal control as against regulation by the State Corporation Commission. This protection came in handy when in our State the Tax Commission insisted upon the water departments paying a sales tax. Remember that the path of the privately owned utilities is not always rosy.

FUNDAMENTAL PRINCIPLES

In the preparation of any budget it is necessary to make a careful analysis of the situation. First, we should consider the scope of the budget. If the department operates as a utility we should consider it on that basis and provide for fixed charges as well as operations

and expansions. Whether or not the department is operated as a utility or as a governmental function there should be a definite relation between revenues and expenses including fixed charges. These fixed charges should include interest on outstanding water improvement bonds and sinking fund payment for retirement of such bonds. As to whether or not depreciation should also be provided for and set up in the annual budget is not only a matter dependent upon the method of operating the department, but also of the propriety of such a charge in addition to a bond retirement sinking fund. Where operated as a governmental function these items would not appear in the budget, but only figure in its preparation as a gauge of the relation of expenditure to earnings.

Unless it is a policy of the municipality to operate the department deliberately without regard to revenues any budget should be based upon business to be done and revenues expected, just as a private business insofar as possible. However, the principle of confining budget expenditures to earnings, even for operation, cannot always be adhered to, too closely. It may be necessary from a standpoint of policy or of public welfare to ignore that principle entirely.

There are some cases in which a social or health relation justifies undertakings by a governmental agency which are not justifiable from a dollars and cents standpoint, but certainly are justified as a general public welfare expedient.

This flexibility to meet conditions is one of the advantages of municipal ownership. With water of proper quality and sufficient quantity so vital to health and welfare it is proper that water plants should be governmentally owned and the principles of sound business not be too rigidly adhered to.

On the other hand, some municipalities use the water department as a revenue producing agency to maintain other functions of government. This is fundamentally wrong and in contradiction of the reasons for public ownership outlined above.

Then again we must balance against altruistic ideas, as well as against ambitions for perfection in plant, the fact that there is a continual tendency towards increase of governmental and managerial functions. While we can cite the fact that water is still free if we care to go down to the river or branch, dip it up, carry it home in a jug and take chances upon the contamination to which it has been subject, we must also remember that true economy and operating efficiency are important factors in the preparation of any budget.

We must also consider the source of the funds necessary to finance the budget. This is the all controlling factor in budget making, but we should not permit it to cause inadequate planning. Curtailment of program is better than inadequacy of design.

The first consideration should be to serve the community adequately. Factors in this are the growth in population, if any, industrial development, building activities, real estate development, and health conditions and the physical conditions which it is necessary to meet to provide a satisfactory water supply.

An analysis of the situation with regard to these factors will affect operation expenditures and also measure the requirement for expansion of facilities.

If the municipality is undergoing a period of growth, as is the case with most of us, then the general plan for ultimate development of the system must be kept before us in the preparation of the budget. This likewise involves a matter of policy which is in turn affected by expediency. A municipality may adopt a pay-as-you-go policy and then conditions may arise which require a departure from that policy or vice versa. In principle, capital expenditures or outlays have no place in an operating budget, or at least they should be financed from sources other than water revenues. For instance a water utility owning lands from which it obtained oil or other mineral sales would be justified in using such funds in capital expenditures to be provided for in the budget. Other cases might be where through wrong influences a community refused to authorize the issuance of bonds and water revenues afforded the only means of financing.

These things directly involve the qualifications necessary to prepare a budget. It is essential that the person or persons assuming this responsibility be of sound judgment and of an analytical mind. They should be familiar with the principles and mechanics involved. They should be conversant with and if possible skilled in the maintenance of engineering structures and establishments, with their operation, with materials, informed on the principles of accounting and experienced in business administration. Naturally the head of the department should be best equipped along these lines to direct the work and be responsible for the preparation of the budget for his department.

It is most desirable and essential that he be familiar with the department's needs and that his staff be equally well informed. He should have the confidence of his staff as well as of the governing

body, and it is essential that this confidence be mutual so that he may have the advantage of their assistance to the fullest extent.

The mechanics of preparation of the budget is not a one day's or one week's job. It extends or should extend over the whole year, and much thought should be given to it, not only by the head of the department but by the sub-heads or members of the staff as well.

A practice advisable to follow is to collect notes of ideas or of apparent needs as occasion affords and file these away in a special budget file. Staff members are encouraged to make suggestions for this purpose and use their own initiative and thought in planning ahead. When budget assembling time arrives these notes are examined for guidance in forming the budget. Ideas for curtailment of expenditures are not as generally included but they should be.

At some season of the year, in advance of budget preparation time, a careful physical inspection should be made of all department property and work notes of material and labor required for proper maintenance and repair with indication of relative priority which should be given to the different items. This inspection is necessarily affected by the general policy of repairs and maintenance as well as by the economic situation of the times.

The condition and necessity of repairs on under ground structures may be ascertained from such inspections and observations which can be made in connection with making repairs and installing new connections, etc.

Such inspections and notes afford a definite basis for working up a yearly program of maintenance and repairs which can be defended against encroachment if necessary.

It goes without saying that the budget of the year previous should be used as a guide whether it be for a contrast or as a model. It should be carefully reviewed for possibilities of improvement in efficiency and economy, but a water department executive should take *warning* to avoid dropping into a rut and doing the same thing year after year simply because that is the way it has been done and because change requires exertion and activity on his part.

The old budget should be carefully scrutinized for opportunities to reduce expenses and effect economies. This does not necessarily mean paring salaries or eliminating jobs. Sometimes that can be done and should be done when advisable. This sometimes presents obstacles especially if jobs are considered as some politician's spoils. In some municipalities in preparing a budget, the head of the depart-

ments depend upon a nucleus of old reliable employees to carry on the work with an extra allowance of jobs over and above to take care of political proteges. Of course, such a condition is deplorable and discouraging, but many public executives have to contend with it and a frank admittance of its existence and a discussion might lead to improvement in the situation. Economies in the past few years have cut down the abuses in this connection.

Any changes in the basic handling of the departmental affairs should next be given attention and necessary provisions made therefor, if any are made.

A study should be made through such means as are available of the volume of business to be expected and these data taken into consideration in preparing the budget.

If an increased volume of business is expected this will mean not only increased force, but especially more fuel, supplies and materials generally. Provision must be made for the necessary additional services, and meters which may be expected during the year.

More business means more expense, but also greater opportunities for economical practice.

The matter of improvements is probably the last matter to be considered, although it is necessarily a serious one and is dependent upon the policy of the municipality. If outlays are considered a part of the operating budget the scheduled part of any program of systematic increase or expansion of facilities should be included. To the extent possible the cost of these should be worked out and approximate figures should not be used. Very often we find that we bought the cloth without measuring the man for the suit.

While the budget should conform to available funds, I have shown what I feel those funds should be. Water revenue should go for operations with a small portion for improvements, but outlays as a whole should come from sources other than a direct assessment against water consumers by means of water rates.

Whatever the policy, the waterworks man should prepare a budget which he can justify under that policy and then fight for it within the bounds of propriety.

We should not countenance padding a budget, but should make an honest recommendation which we would follow were it our own private business. Nevertheless, the sponsor of the budget should be familiar with it in detail, sufficiently so, that he can say instantly and decisively where he can best afford to pare it when necessary.

Preparing and passing a budget are two different things. The first may require principally knowledge, but the latter requires a combination of knowledge, diplomacy, psychology and possibly a little politics.

Although the relation of earnings to budget expenditures has been discussed this does not necessarily refer to the means of financing, which is of prime importance. In some cities, as in our own, the amount of revenues as a whole, of the previous year, is the limiting basis of appropriations for the year. This sometimes works a severe hardship, although it is comparatively easy to secure supplemental appropriations to handle increasing business.

Where the department is operated as a governmental function, correlation and coöperation with other departments is necessary. This often means give and take. The water department usually does the giving. A sympathetic attitude on the part of the governing body is essential to accomplish anything. This attitude is a direct reflection of the confidence in the department. The department head submitting his budget must be able to back up his statements and figures with a knowledge of facts. This means familiarity in detail with every item in the budget. Furthermore, this means that the passing of a budget also is not the work of a week or even a month, but of the whole year in seeing that the governing authorities are informed along lines which will enable them to pass intelligently upon the budget when it is presented to them.

It is a direct test of the aggressiveness, progressiveness and ability of the department head.

However, just as great a measure of his capacities, is his ability to adjust himself to conditions imposed upon him by the budget as passed. He must remember that the governing body is the authority and while he should do that which he feels is to the best interest of the department, when he is over-ruled he must take what is allotted and do the best he can. He must be a good soldier. He may estimate the situation and make provision for the best use of all resources that may be at his disposal, but if some misfortune occurs, if part of these resources are cut off his worth is tested by his ability to take what is left and carry on courageously, cheerfully and above all loyally. The test of a good engineer, serving the public, is to take what he has, with what the community is able and willing to add and render adequate service.

A budget once passed and allocated should be adhered to. Keep

within your budget. Subordinates should be taken into your confidence. It is equally necessary to have not only their loyalty and confidence, but their coöperation and assistance.

Monthly statements of expenditures in detail should be prepared as well as statements of earnings. These should be analyzed and excessive expenditures sharply checked and closely watched. Here again the subheads should be made to feel responsible for their part of the department. They should be required to keep monthly statistics upon their operations and these consolidated in monthly operation statistical reports showing the financial standing of their part of the operations. A strict accounting should be kept and budget expenditures allotted upon a monthly or other periodical basis. Of course, seasonal variations and other circumstances will justify departures. Frequent contacts between subheads of the department with frank discussions of operations and problems of the department will greatly promote efficiency and economy.

On the whole a well prepared budget is not difficult to conform to and a well organized, efficient department will have no difficulty in conforming to a well balanced budget.

The budget is the foundation upon which the structure of operation is built. A good foundation is the major part of a serviceable and enduring structure.

(Presented before the Southwest Section meeting, October 15, 1935)

EXPERIENCES WITH THE TREATMENT OF MONONGAHELA RIVER WATER

By Frank W. Bouson

(*Chief Chemist, South Pittsburgh Water Company, Pittsburgh, Pa.*)

The Monongahela River, a tributary of the Ohio River, is formed by the union of the West Fork and Tygart Valley Rivers near Fairmont, W. Va. The trunk stream flows northward into Pennsylvania over a course of 128 miles and unites with the Allegheny at Pittsburgh to form the Ohio River. Its chief tributary is the Youghiogheny which empties into the Monongahela River at McKeesport.

To provide slack water navigation on the Monongahela Rive between Pittsburgh and Fairmont, W. Va., a series of locks and dams have been constructed.

The area drained, which is estimated at 7390 square miles, is a fertile country in which are extensive bituminous coal deposits. The mining of coal, its destructive distillation in coal by-product plants, and the manufacture of by-product and bee-hive coke so necessary in the production of steel in the Pittsburgh district, are the main industrial activities of this area.

Industrial wastes and acid mine drainage in large quantities are allowed to enter the main stream and tributaries without regard for other indispensable purposes for which the river water must be used. The quantity of acid mine drainage entering the Monongahela River is such that the natural alkalinity of the river has been destroyed and the river remains acid throughout the year.

Free sulphuric acid, acid salts of iron and aluminum, and carbon dioxide constitute the total acidity in the river water. The exact chemical formulae of the acid salts of iron and aluminum found in the river water are not known. The majority of the hardness present in the Monongahela River is in the sulphate form and consists mainly of calcium and magnesium sulphates plus the acid constituents. The total hardness varies over a wide range, depending on the stage of the river and which section of the water shed is furnishing the greater volume of water. The changes in total hardness are

sometimes very rapid. Within a period of three hours, a drop in total hardness from 190 to 83 p.p.m., has been experienced. During the summer of 1930 an extreme hardness of 550 p.p.m. in the river water was reached. The minimum hardness has been as low as 30 p.p.m.

TREATMENT

Since 1924, the South Pittsburgh Water Company, which takes its raw water supply from the Monongahela River about three miles above the conjunction of this river with the Allegheny river, has been softening this supply when necessary to a total hardness of 95 p.p.m. before distribution.

As the water flows from the intake to the low service pump sumps, soda ash is added by dry feed machines to neutralize the majority of the mineral acid, leaving only a trace. The chemical reaction between the soda ash and the acid present in the river water is immediate and softening of this portion of the total hardness is effected with the least expense. Protection of the condensers, pumps and low service pipe lines from the corrosive action of the free acid in the river water is also accomplished. This treatment is controlled by titration tests every half hour using n/50 sodium carbonate solution with methyl orange as the indicator. Every effort is made to adjust this treatment so as not to exceed the neutralization of the free acid. If the treatment is allowed to pass this point, the excess soda ash will combine with a portion of the acid salts of aluminum and iron in the raw water. This is not desired in this phase of the treatment because the effectiveness of this water for future use, as a by-pass medium for carbonization of the softened portion of water, would be partially destroyed. By neutralizing with soda ash beyond the free acid, the control of the amounts of acid salts softened cannot be maintained by a simple, quick analysis such as by a titration.

After this preliminary treatment, the raw water is pumped to the softening plant where it is divided into two portions. The larger portion is aerated and passes through the softening plant where it is softened by the lime-soda process to a predetermined point. The smaller portion by-passes the softening plant and is mixed with the softened water to effect the carbonization of the softened portion.

Aerating the portion of the water to be softened, removes the carbon dioxide. By so doing, a saving is made in the amount of lime necessary to convert all of the alkalinity in the softened water to

calcium carbonate. The amount of soda ash fed at the softening plant to furnish a final effluent in which the total hardness is between 90 and 100 p.p.m. depends on the quality of water to be treated and the effectiveness of the by-pass water used for carbonization. This determination is made by the operating chemist and is calculated from the incrustant analysis of the water to be treated. The soda ash and lime solutions are added after aeration and as the water enters the mixing tanks. These mixing tanks are operated two in parallel and two in series and are equipped with motor driven stirring devices. The speed at which the stirring devices are operated is such as to afford a thorough mix of the chemicals added to the water and to accelerate the formation of the precipitates resulting from the chemical reactions of the softening process. The stirring action imparted to the treated water prevents any settling of the precipitates in the mixing tanks. The retention period of the mixing tanks, for a normal flow of 15 M.G.D. rate, is 40 minutes.

On leaving the mixing tanks, the softened water, with its intended precipitates in suspension, enters the clarifier where the water becomes quiescent and sedimentation takes place. The clarifier is equipped with a Dorr mechanism for the continuous removal of the sludge which is drawn off through a small orifice under an existing head of 20 feet. The size of the orifice necessary for the removal of the sludge from the clarifier varies from 0.5 to 0.75 inch, depending on the amount of softening and the quantity of water being treated. About 90 per cent of the suspended solids is removed by the clarifier. The sludge removed will run as high as 26 per cent solids.

The softened water passes from the clarifier through a flume and over a weir into the softening plant basin. The weir, extending the full width of the basin, affords an even distribution and flow of water through the basin. This basin, having a capacity of 5 million gallons with a retention period of at least 6 hours, allows sufficient time for the completion of the chemical reactions of the softening process.

Carbonization of this softened supply is now effected by two methods used in combination. When the softening plant was constructed, the total acidity of the Monongahela River water at all times, was great enough to accomplish carbonization of the softened water by maintaining a proportion of softened to by-pass water that the total hardness of the mixed water would not exceed the standard of 100 p.p.m. hardness in the filter plant effluent.

INDUSTRIAL WATER TREATMENT

In recent years, a number of industrial plants above our intake, have found it profitable to protect their equipment against the corrosive action of the river water which is used in their plants for cooling purposes in their various processes. This protection is accomplished by neutralizing with lime the total acidity in the water used in their plants. The addition of lime to this water destroys the total acidity with the formation of calcium sulphate and calcium bi-carbonate; thus, having no softening effect on the water treated. This water, being used in most cases for cooling purposes only, is discharged back into the river after performing its intended function. The quantity of water taken from the river, treated, used and returned to the river by these industrial plants has not only a diluting effect on the total acidity of the river, but a further reduction of the total acidity in the river takes place due to the calcium bicarbonate content of the discharged water.

During the summer of 1930, when the flow of the river was at a minimum due to the excessive dryness over the water shed, one industrial plant, located on the Monongahela River above the junction of the Youghiogheny, rightly describes its size by saying that they had changed the Monongahela River from an acid to an alkaline stream. At this time, the acid discharge of the Youghiogheny River, which empties into the Monongahela four miles below this plant, returned the main stream again to the acid condition, but with a greatly reduced acid content.

CARBONIZATION

The river water during this period at the Water Company intake reached a peak hardness of 550 p.p.m. with a total alkalinity of 6 p.p.m. and a phenolphthalein acidity of 70 p.p.m. The effectiveness of this water for by-pass purposes was insufficient to carbonate properly the portion of softened water and maintain the standard of 100 p.p.m. hardness in the mixed water. Immediately following this experience, a carbon dioxide generating plant and necessary equipment, were installed at the softening plant to be used in conjunction with the split treatment for the carbonization of the softened water.

Carbon dioxide is produced by burning natural gas in a closed furnace. The necessary air to supply oxygen for the combustion of the gas is drawn through ports in the lower portion of the furnace.

From the furnace the burnt gases pass through a scrubber to the suction of the compressors. The compressors raise the gas pressure sufficiently to overcome the hydrostatic head in the carbonization tank which is equipped with a grid system to diffuse the gas uniformly into the water passing through the tank to be carbonated. A recording gauge, registering the percentage of carbon dioxide, is provided for the control over the operation of this equipment.

The carbon dioxide plant is now used at all times to supplement the split treatment for complete carbonization of the softened water and to control the pH value of the water entering the filter plant sedimentation basins. At least every hour analyses are made to control this important phase in the treatment of the Monongahela River water.

MAINTENANCE OF FILTERS

In the previous history of the plant, trouble was experienced in maintaining the sand, gravel and strainer system of the rapid sand filters in good operating condition. A close study of the filters during this period revealed that the first indication of the trouble was the formation of a heavy mat on the sand surface which resisted removal by the high velocity wash given the filters every 24 hours. As this mat continued to build up, striated cracks appeared, and on washing the filter, the mat would break along the lines of the cracks. The broken pieces of mat, instead of being completely disintegrated by the wash, would form mud balls due to the tumbling action exerted by the upward flow of the wash water. A large proportion of the mud balls settled on the gravel in the reduction of the wash water at the end of the wash. Serious disturbance of the gravel followed, due to the uneven distribution of the wash water. On inspection, the gravel was found to contain a heavy deposit of aluminum hydroxide.

During this same period a complex deposit in all galvanized lines in the distribution system was noticed. An aluminum compound was the predominant component in this deposit.

NATURAL COAGULANTS

It has been our experience that the acid salts of iron and aluminum present in the Monongahela River water could be used for coagulation in preparing the water for filtration without the use of any additional coagulant such as alum. With the exception of a few

days each year, following heavy rainfalls on the water shed, the quantities of these acid salts in the river water are sufficient to coagulate the settled water. The equivalent of the acid salts of aluminum in the raw water in terms of alum have been found to be as high as 10 grains per gallon. Alum is used only during the short periods of high river stage to supplement the low aluminum content of the raw water.

These two problems, involving aluminum deposits, indicated that the maximum precipitation of the acid salts of aluminum found in the raw water was not being attained in the coagulation basins at the filter plant. A survey of the pH values and aluminum content of the water, after each phase in the treatment, was made. It was found that the practice of carrying a total alkalinity of 20 p.p.m. in which 1 to 3 p.p.m. existed as carbonate in the coagulated water allowed 2 to 10 p.p.m. of aluminum to remain in solution. The pH value of this water varied from 7.6 to 8.0. On filtering this water, a lower pH value was noted in the filter effluent with a loss in the aluminum content. The precipitation of some of the aluminum, due to the loss in pH value, was taking place in the sand and gravel of the filters resulting in the filter trouble we were experiencing.

The aluminum content of the plant effluent during this period was found to be from 1 to 10 p.p.m. and was the source of the aluminum component of the deposit experienced in the galvanized lines of the distribution system. During the survey, to determine the cause of the deposit, it was proved that a reaction would take place between the alkalinity created by lime in treating acid water and the zinc of the galvanized lines resulting in a loss in alkalinity in the water. The lowering of the pH value of the water in the galvanized lines caused precipitation of some of the dissolved aluminum content of the water which would either deposit or pass on with the water as a discoloration.

The solution of both these problems rested with a more complete precipitation of the acid salts present in the Monongahela River water. By laboratory experimentation, the optimum point for the precipitation of these acid salts was found to be at a pH value of 6.9 in the coagulated water. It was also noted that, when the pH value of the coagulated water was below 6.8, the iron salts are incompletely precipitated, and when the pH value is above 7.0 complete precipitation of the aluminum salts does not take place.

The control of the pH value of the coagulated water between 6.9

and 7.2 in the filter plant basins has been attained either by increasing the proportion of by-pass water, which is acid in character, or by increasing the amount of carbon dioxide used in the carbonization of the softened water. By maintaining the pH value of the settled water within this narrow range, improved coagulation can be readily observed when treating a water having turbidity.

The physical condition of the filters has been improved to the extent that the time between necessary complete overhauling of the sand, gravel, and strainer system of the filters has been extended from 1 to 5 years. As the plant effluent now contains less than 1 p.p.m. aluminum in solution, the deposit of aluminum in the galvanized lines and the discoloration of the water due to precipitated aluminum has been eliminated.

TASTE AND ODOR

Controlling the coagulation of the acid salts in the Monongahela River water also plays an important part at times in the prevention of taste and odor in the plant effluent. On a number of occasions a chlorinous taste had appeared in the distribution system accompanied with a much greater chlorine demand in the filtered water. The taste followed a heavy rainfall on the water shed and at the crest of a rapid rise of the river. In each case the turbidity of the river water was above 200 p.p.m. During the rapid rise in the river the quality of the water changes widely. In adjusting the chemical treatment to meet the changes in the raw water, difficulty in maintaining the optimum of precipitation is increased. The tendency was to carry a higher pH value in the settled water in anticipation of the addition of alum if necessary. Samples from the discharge of the sewers of the coal by-product plants above the Water Company intake, which are taken daily and brought to the laboratory for analysis of their taste producing qualities, could not be blamed for the chlorinous taste.

In studying this problem, samples of water from different points of the softening plant and purification plant, following each phase of treatment, were chlorinated with equal quantities of a chlorine solution. The quantity of chlorine solution used was determined by the amount necessary to produce a residual content of 0.3 p.p.m. in the filtered water sample. These samples were then concentrated by distillation in a proportion of 6 to 1, and the taste and odors of

the distillate noted. A very faint taste was present in the acid river sample. This taste may be described as astringent and was not chlorinous in nature. In the outlet of the clarifier and the outlet of the softening plant basin samples, strong chlorinous taste and odor were present. The inlet of the filter plant basin and the filter effluent samples had a faint chlorinous taste.

The absence of a chlorinous taste in the acid river water samples and a strong taste in the highly alkaline samples from the outlet of the clarifier and the outlet of the softening plant basin, indicated that the high pH value of the water at these points was a contributing factor in creating the taste.

Working on the hypothesis that the disturbing compound was in suspension in the acid river water during the high turbid stages of the river and was being converted to a soluble compound by the increase in pH value of the treated water, effort was made to reprecipitate the offending compound and remove it by coagulation and filtration before the addition of the usual dosage of chlorine. This was accomplished to a surprising degree by maintaining the coagulated water strictly at the optimum point of precipitation of the acid salts of iron and aluminum which would be slightly on the acid side at a pH of 6.9.

During this period of experimentation, a chlorinous taste developed in the distribution system accompanied with the high chlorine demand of the filtered water but without rainfall and rapid rise in the river. Investigation of the river disclosed that extensive dredging of the river channel in the vicinity of a large coal by-product plant above the intake was the cause. The dredgings removed from the river bottom consisted partially of sludge impregnated with insoluble by-product compounds lost in the operation of the by-product plant. The disturbance of this accumulated pollution by dredging caused a portion of this pollution to be picked up by the current of the river and carried in suspension down stream past the Water Company intake. Locating the cause of the chlorinous taste in the effluent in this instance explains the presence of this pollution during a rapid rise in the river when its swift current exerts a scouring action on the river channel.

As other tastes and odors appear in the raw water from time to time which are capable of being removed by activated carbon, activated carbon at the rate of 14 pounds per million gallons is added

continuously to the settled water as it flows to the filters. The improved taste of the filtered water is well worth the expense of this treatment.

The filter effluent, having a total alkalinity of 18 p.p.m. and 1 to 2 p.p.m. carbon dioxide in solution has a pH value of 6.9. As a water with these characteristics may cause red water troubles in the distribution system, a clear solution of lime is added to the filtered water to increase the pH value of the plant effluent to 7.3. This pH value in the effluent has been found to be the most stable point at which to carry the alkalinity.

(*Presented before the Central States Section meeting, August 22, 1935.*)

CONSERVING OUR NATIONAL WATER RESOURCES

By Frank R. Shaw

(Sanitary Engineer, U. S. Public Health Service, Chicago, Ill.)

In considering the problem of conserving our national water resources, we are concerned with the various forms in which and places wherein water exists and the changes and effects which transpire in its travels, as well as the uses to which it is put. The problem is national in scope and involves every phase of the hydrologic cycle.

Water occurs as liquid or ice in the oceans, lakes, rivers and other surface depressions; as liquid or frost in ground and underground storage; as clouds, fog, mist and vapor in suspension in the atmosphere. It changes from one to another of these forms and moves from one to another of these places. The hydrologic cycle (natural circulation) involves, (a) *evaporation* from exposed water and earth surfaces and *transpiration* from ground storage through the leaves of trees and other vegetation; (b) *precipitation* as rain, snow, fog or dew when the moisture laden air strikes sufficiently cool air to cause condensation; (c) *absorption* by the surface soil and *infiltration* into the underground strata of soil, sand, gravel or porous rock; (d) *surface run-off* by flow over the surface of the ground to creeks and rivers and thence to lakes and oceans when the rate of precipitation is greater than the rate of absorption and infiltration. The water stored by infiltration is known as ground water and the surface of the underground reservoir so created is called the water table.

Absorption, infiltration and run-off are closely related. Absorption and infiltration vary with the characteristics of the soil and conditions which tend to retard or prevent surface run-off. Run-off varies with intensity and duration of precipitation, the absorption and infiltration capacity of the soil and conditions which tend to assist surface and stream flows. Man seriously disturbed the natural arrangement by acts which interfered with evaporation and transpiration, which decreased absorption, infiltration and ground-water storage, and which accelerated run-off. The primary factors of this human interference have been, and still are, the stripping of the forests without reforestation; unnecessary removal of the vegetative

cover of the soil; improper tilling of the soil; illogical and unwarranted drainage; excessive straightening of streams and channelling. The effect has been far-reaching and the harm done in the United States, up to the present time, is great. The effects which are apparent are soil erosion; lowering of the water table in certain areas; floods; excessively low dry weather flow in certain of our streams; interference with navigation; lack of more uniform dilution for the disposal of waste and the silting of reservoirs. The further effects which are logical, if not so apparent, are as follows,—reduction of and irregularity of precipitation due to the reduction of evaporation and transpiration; increase in the mineral content of the ground water in certain areas; increase in the mineral content in surface waters used for domestic and industrial purposes; destruction of oysters and clams in the estuaries of bays, gulfs and oceans due to silt deposits, and the occurrence of high salinity, resulting from excessively low flow, which permits the invasion of its enemies such as the drill.

In truth, conservation and control of water resources begins with the clouds and ends with the ocean.

The present seriousness of many of these effects is beyond the conception of most of us. Probably the greatest value of the monumental work and reports of the National Resources Board, and its allied committees and activities (1934 and later), was to appraise the seriousness of the situation; inventory such information as was then available; point out the need of reliable scientific data; emphasize the importance of thinking in terms of current and logical use; indicate the necessity of national and long time planning and to point the way to unified development through a permanent federal advisory and promotional agency.

Evaluations of some of these effects have appeared in recent literature. Recent measurements indicate that it is entirely rational to assert that, with continued squandering of the top soil, this country has left only about a century of virile national existence. Soil erosion specialists state that the dust storm of May 11, 1934 swept 300 million tons of fertile topsoil off the great wheat plains and that 400 million tons of soil material are washed annually into the Gulf of Mexico by the Mississippi River. Already 100 million acres of once fertile farm land has been made unprofitable for farming. The water table in certain areas has lowered 10 to 30 feet. The economic and financial loss from floods can well be judged by the recent ones in the New England states and the Ohio Valley—the direct loss being prob-

ably a half billion dollars. Depleted stream flows caused the doubling and trebling of hardness and in the Delaware River alone it caused the expenditure of $7,000,000 between 1929 and 1933. It is estimated that the railroads east of Pittsburgh suffer an economic loss of $12,000,000 to $20,000,000 annually because of the chemical quality of surface water due largely to mine and industrial wastes.

REPORTS OF NATIONAL RESOURCES COMMITTEE

The importance and timeliness of the 1934 report of the National Resources Board, now called the National Resources Committee, cannot be over-emphasized. It laid the foundation for the activities and reports which have followed. Although the accomplishments are meager as compared to the immense problem, a commendable beginning has been made and it is the writer's opinion that machinery has been set in motion, which cannot easily be stopped, to correct the ruin we have accomplished and to conserve our wonderful heritage for those who follow us. The outstanding accomplishments to date have been, (a) the creation of the State Planning Boards and the progress they have made in studying and gathering data on land and water uses and abuses, analysis of these data and the framing of long time planning; (b) the reports and activities of the Water Resources Committee, the report of its Special Advisory Committee on water pollution and the report of its Special Advisory Committee on standards and specifications for hydrologic data; (c) the reports of certain State Planning Boards and the recent general report on "State Planning;" (d) the very recent "Outline of Suggested Procedure for Water Studies by State Planning Boards, February 1936."

During the early part of 1936 the Water Resources Committee took took steps to begin promptly a study of water resources by drainage basins. It is planned to submit a report to the President on December 1, 1936. It is intended that the report will cover the following points with respect to each of the major drainage basins and special problem areas, shown on figure 1.

(1) The outstanding problems of water use and control.

(2) The broad outlines of a reasonable and integrated plan of development.

(3) The specific construction and study projects which, in the light of available information, are consistent with the broad plan and should be undertaken immediately or in the near future.

The country has been tentatively subdivided into the seven-

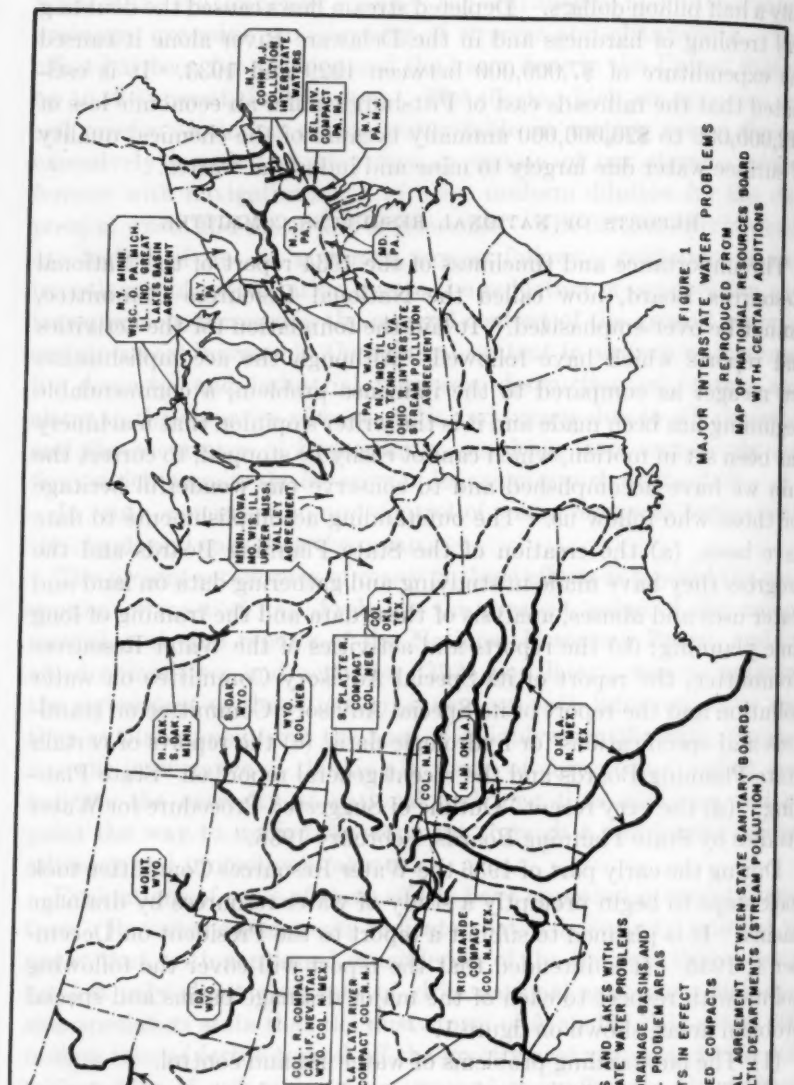
N.Y. CONN. N.J. POLLUTION INTERSTATE WATERS
DEL. RIV. COMPACT PA. N.J.
N.Y. PA. N.J.
N.J. PA.
MD. PA.
N.Y. MINN. WISC. O. PA. MICH. ILL. IND. GREAT LAKES BASIN AGREEMENT
N.Y. PA.
PA. O. W.VA. KY. N.Y. MD. ILL. IND. TENN. N.C. VA. OHIO R. INTERSTATE POLLUTION CONTROL STREAM POLLUTION AGREEMENT
MINN. IOWA MO. WIS. ILL. UPPER MISS. VALLEY AGREEMENT
COL. OKLA. TEX.
S. PLATTE R. COMPACT COL. NEB.
N. DAK. S. DAK. MINN.
S. DAK. WYO.
WYO. COL. NEB.
COL. N.M.
N.M. OKLA.
OKLA. N. MEX. TEX.
MONT. WYO.
IDA. WYO.
RIO GRANDE COMPACT COL. N.M. TEX.
COL. R. COMPACT CALIF. NEV. UTAH WYO. COL. N. MEX.
LA PLATA RIVER COMPACT COL. N.M.
WASH. IDA. ORE. MONT. WYO.
STREAMS AND LAKES WITH INTERSTATE WATER PROBLEMS
MAJOR DRAINAGE BASINS AND SPECIAL PROBLEM AREAS
COMPACTS IN EFFECT
PROPOSED COMPACTS
INFORMAL AGREEMENT BETWEEN STATE SANITARY BOARDS OR HEALTH DEPARTMENTS (STREAM POLLUTION)

FIGURE 1
MAJOR INTERSTATE WATER PROBLEMS
REPRODUCED FROM MAP OF NATIONAL RESOURCES BOARD WITH CERTAIN ADDITIONS

FIG. 1

teen (17) areas as shown on figure 1. One water consultant will be assigned to each area. He will work with the state planning boards and regional planning commissions and seek the assistance and advice of such state and local agencies as are concerned with or have data regarding the matter in hand. Each consultant will have a technical assistant to aid him. It is hoped that a technical assistant can be made available in each state. The committee will make avaliable to the water consultants special technical consultants for conferences relative to difficult problems. A regional and assistant regional coördinator will assist and guide the water consultants. The Director will spend much of his time in the field. The Assistant Director and Office Coördinator in Washington will correlate the field data and furnish the water consultants with all information available with regard to their respective areas.

The Soil Conservation Service, together with the Resettlement Administration and Rural Electrification Administration, recently published a book entitled "Little Waters," which is written in popular style. It deals mainly with soil erosion and how it can be corrected by contour plowing, terracing, diking, strip farming and mulching. It stresses the importance of holding the "little waters" and suggests the possibility of encouraging the impounding of water and reforestation by tax reduction or the giving of bounties.

The Soil Conservation Service, mentioned above, was created recently. This service is busily engaged promoting the above procedure on farm lands and other areas where needed. It is also gathering data regarding soil problems.

The U. S. Geological Survey will soon publish comprehensive studies entitled "Flood Flows in the United States" and "Rainfall, Run-off and Ground Water Relations".

The Corps of Engineers of the U. S. Army are engaged in studies regarding floods and their control by reservoirs, spillways and protective works, and certain problems in hydraulics.

All of the above activities were created or extended as a result of recommendations of the Water Resources Committee of the National Resources Committee.

The general objectives of the Water Planning Committee were set forth, as follows:

(1) To develop more productive uses of water resources—power, water supply, navigation, irrigation and recreation.

(2) To eliminate, modify or neutralize harmful influences of water, such as floods and erosion.

(3) To eliminate, modify or neutralize harmful handling of waters —pollution, waste through irrational run-off, and drainage.

(4) To accomplish the above purposes effectively from a point of view of technology, geographical conditions, existing public agencies, and the intelligent understanding of good-willed citizens.

The Inventory Section of the Water Planning Committee Report presents for the first time a brief but coördinated picture of our present knowledge of precipitation, run-off, ground water, evaporation, water quality, and coastal water for the country as a whole. It portrays the extent to which our waters have been used for public and industrial water supply, power, navigation, waste removal, irrigation and recreation. It indicates the problems of flood control and drainage. It makes clearly apparent how deficient we are in exact or adequate knowledge regarding so much of this fundamental data. For this reason, it is imperative that we begin at once a far more comprehensive and scientific approach to the investigation of our water resources, involving particularly standardized and coördinated procedure for the collection, compilation and publication of basic hydrologic information.

The lack of standards and specifications for guidance in the conservation of water resources was forcibly pointed out by the Mississippi Valley Committee, now the Water Resources Committee, its sub-committees and advisory committees, and in recent articles. "Standards and Specifications for Hydrologic Data" by the Special Advisory Committee to the Water Resources Committee, published November 6, 1935, meets this challenge in a masterly fashion and can well serve as a model of comprehensiveness for like contributions. This work makes general recommendations regarding publication, personnel and nomenclature and units of measurement and sets up standards for collection, compilation and publication of data on precipitation, snow surveys, surface waters, ground waters, evaporation from water, snow and ice surfaces, evaporation from moist soil and evapo-transpiration. This illuminating work concludes with special projects for the study of infiltration and soil moisture and suggested projects and procedure under Works Progress Administration.

A strenuous effort has been and is being made by the Water Resources Committee to impress upon all of its associates, investigators

and the populace at large that a program for the conservation of water resources can be successful only when properly coördinated and interrelated with plans for the use of the land, for forestry, health, recreation, game management, agriculture and soil erosion control. Likewise, account must be taken of the different possible uses of water. Frederick H. Newell, former director of the U. S. Reclamation Service, listed uses of water in descending order of their importance as follows: (1) human consumption; (2) production of food (irrigation, stock watering, and fish); (3) disposal of waste; (4) industry (water power, steam power and industrial processes); (5) transportation (navigation). The New York Planning Board added recreation.

PUBLIC WATER SUPPLIES

We, as members of this Association, are directly or indirectly concerned with water for human consumption. We are interested in its physical, chemical and bacteriological qualities as they relate to the suitability of the water for drinking and domestic purposes and industrial use. As a group we are concerned with every phase of "Conserving our National Water Resources," and, recognizing the need of well planned and managed study, we should heartily support the program proposed. We are concerned about erosion because the silt settles in natural reservoirs and also adversely affects treatment processes. We are concerned with the lowering of the ground water table and lessening of infiltration as it depletes the ground water supplies and reduces gradual percolation to the streams. We are concerned with the decrease in infiltration because it no doubt has resulted in increases in chemical constituents in ground water supplies in certain areas. We are concerned over the increase in mineralization of water in one aquifer by water from another due to failure to seal borings and due to corroded well casings. We are concerned over the fact that fluoride, which affects the teeth, has been found in certain ground water supplies. We are concerned over the possible effects of brine waste upon ground and surface waters. We are concerned over the possibility of contamination reaching ground water supplies through the use of abandoned wells for the disposal of liquid wastes. We are concerned about floods since they submerge well fields and water purification plants and thus introduce health hazards for which we are responsible. We are concerned about low stream flows because this condition increases the natural chemical

constituents in the water and reduces the dilution for domestic and industrial wastes. We are concerned about improper and excessive discharge of domestic and industrial waste as such increases the cost and endangers the quality of the water from treatment plants.

Figure 2 shows the weighted average hardness, by States, of water furnished in 1932 by public supply systems in over 600 cities in the United States.

An important problem in water conservation, and one which affects a large percentage of the population as well as being of much direct concern to many of the members of this association, is that of stream pollution by domestic and industrial waste. The general

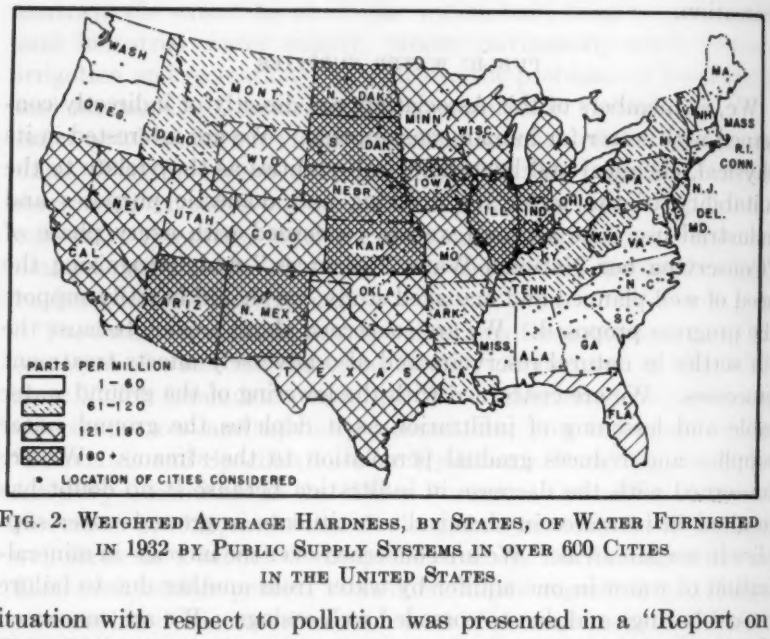

FIG. 2. WEIGHTED AVERAGE HARDNESS, BY STATES, OF WATER FURNISHED IN 1932 BY PUBLIC SUPPLY SYSTEMS IN OVER 600 CITIES IN THE UNITED STATES.

situation with respect to pollution was presented in a "Report on Water Pollution" by the Special Advisory Committee of the National Resources Committee. The report was concerned with water pollution as regards legislation, the public health and biological aspects, industrial wastes, water quality standards, the economic aspect and recommendations.

The committee's recommendations were as follows:

(1) That where drainage area authorities exist for the comprehensive development and control of water, their scope be made sufficiently broad to include control of pollution.

(2) That no basic changes in existing federal law with reference to water pollution control be made until the experimental program presented later herein shall have indicated whether or not such changes are desirable and feasible.

(3) That simplification and coördination of state laws be effected to provide for the following minimum requirements:

(a) Adequate administrative control;

(b) Delegation, to the administrative agency, of power to determine the nature and extent of pollution prohibited by the statutes, and to establish limitations of pollution;

(c) Appropriate mandatory powers, particularly the power to compel the installation of essential remedial works and force other necessary action;

(d) No limitation on the taxing or bonding power of municipalities, when applied to remedial works ordered by the administrative agency;

(e) Power to require facilities through sewerage districts, sanitary districts, or otherwise, that will enable municipalities and industries to comply with the law.

(4) That broader authorization for research be granted to those agencies of the federal government which are already concerned with various phases of the problem, and that adequate funds be provided for properly coördinated water pollution investigations.

(5) That powers and funds be granted to an appropriate federal agency to institute a coöperative program of investigation with legally constituted state agencies for such special studies as appear desirable, and particularly for the development of appropriate standards for water use and control.

(6) That in order to stimulate the construction of pollution abatement works, funds for the purpose be made available by the federal government to local public and private agencies on a grant-in-aid or loan basis. Lacking any precedent for the designation of appropriate basis for such allocations, the committee recommends the creation of a demonstration unit on a river system selected for that purpose. The committee recommended the creation of a full-scale demonstration on the Potomac River for the establishment of a basis for a fund allocation and for federal coöperation in pollution abatement involving several states.

The report revealed that state agencies in general are opposed to any extension of federal regulatory authority with respect to water pollution control. They favored the federal government's confining its activities to investigation and research and to acting as a coördinating agency.

Opinion is divided as to the efficacy of formal state compacts, which compacts can be entered into by states only with the consent of Congress. It must be remembered that the failure of many of the past formal compacts, some of which are indicated on figure 1, was possibly due to the fact that they involved competitive factors such as water rights and state boundaries. It is thought by some that such

formal compacts regarding stream pollution would be more successful. It does seem that the interests of the states under such a compact in the conservation of the stream, in the coördination of state laws, and in the establishment of standards might be similar and that differences of opinions might be brought to a common ground more easily.

It is generally recognized that progress has been made through informal agreements between the State Departments of Health. In 1924, the Ohio River Interstate Conservation Agreement was entered into by Ohio, Pennsylvania and West Virginia. Subsequently eight other states joined, they being Kentucky, New York, Maryland, Illinois, Indiana, Tennessee, North Carolina and Virginia. This was followed by a like agreement between Maryland and Pennsylvania and an agreement between New Jersey and Pennsylvania. More recently the Great Lakes Basin Agreement was entered into by New York, Minnesota, Wisconsin, Ohio, Pennsylvania, Michigan, Illinois and Indiana. Very recently, within a year, the Upper Mississippi Valley Agreement was entered into by Minnesota, Iowa, Missouri, Wisconsin and Illinois.

A formal compact with respect to pollution of coastal waters, known as the Tri-State Treaty, was entered into by New York, Connecticut and New Jersey. Under this formal treaty, waters are classified as those used for recreational and shellfish purposes and those not so used. Sewage or effluents entering waters of the first class must have at least 60 percent of their suspended solids removed, must have at least 50 percent dissolved oxygen saturation and B. coli not over 1 per cc. in 50 percent of the samples. In waters of the second class, floating solids must be removed from sewage, 10 percent of the suspended solids must be removed, sludge beds must not form, and 30 percent dissolved oxygen saturation must be maintained.

In other agreements the states have agreed that the minimum degree of sewage treatment shall be efficient sedimentation.

APPRAISAL OF STREAM POLLUTION CONTROL PROGRESS

A comprehensive appraisal of the progress made by the states in the matter of stream pollution abatement would reveal considerable acceleration in progress during recent years. Much has been said about the need for stream pollution abatement, and there is no denying that need is urgent, but in recognition of these pioneers much can be said about the accomplishments to date.

A brief questionnaire to the State Sanitary Engineers revealed that, in the 42 states reporting, the sewage treatment plants now operating, being built or financed for immediate construction, 20 percent have been built or financed since about August 1933. In the fourteen states, Delaware, Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, New Jersey, Ohio, Virginia, West Virginia and Wisconsin, the percentage is 22.5. A summary covering the 42 states revealed that 656 plants have been built, are being built or have been financed since the advent of federal financial assistance. Many other plants would have been built if all past applications for financial aid had been approved. The voluntary statements of a few state engineers indicate that applications for financial aid for a considerable number of sewage treatment projects are pending.

Since many of the plants now being built, or recently completed, will serve large cities, including Detroit and suburbs, Minneapolis, St. Paul, parts of Chicago and the District of Columbia, the pictures recently presented in reports will be markedly improved with respect to percentage of population served and pollutional load on streams.

Much has been accomplished in recent years with respect to industrial wastes. Nothing was accomplished during early days by mandatory procedure but progress has been made through coöperation with the industry. In many cases the treatment of the waste has resulted in the recovery of valuable materials and in the development of profitable patents. Such has been the case with paper mill waste and certain of the cannery and packing house wastes. An outstanding case of this is a distillery in Peoria, Illinois, where about $500,000 was expended to overcome a pollutional load equivalent to a population of 1,000,000. Certain patents were developed and not only is it expected to amortize the capital investment in a relatively few years, but a substantial profit will be made from a breakfast food and dog food made from the nutritious substance recovered. This pollution abatement, together with recent sewage treatment plants in the Peoria area, has reduced the population equivalent of pollution load from 4,000,000 people to 2,000,000 people. Steps are being taken for further reduction.

Ohio reported that there are 67 waste treatment plants or processes in operation which cost industry a total of $2,250,000. At the present time 8,000 openings in abandoned mines, which formerly delivered acid wastes to the streams, have been sealed. The work is continu-

ing as a W.P.A. project at the rate of 600 closures per month. In the case of some small streams fish life has already returned.

The loss in West Virginia from acid mine wastes has been estimated at $1,000,000 annually. Two hundred and fifteen abandoned mines have been sealed and the work is continuing.

Trax estimated that the actual cost for water treatment to industry and water treatment plants in a 50 mile stretch along the the Monongahela River from the West Virginia line to McKeesport is $2,196 a day or $801,000 annually. At this rate mine sealing is profitable.

Michigan reports 28 industrial waste treatment plants, Minnesota 5, and Indiana 12. In these states there are many additional cases of screening and lagooning.

Many states in other sections have been active in the matter of industrial waste control.

While there is a great need for establishing pollutional standards for various uses of water, progress in keeping with the personnel and funds available has been made by the Public Health Service in setting up certain standards and procedures. The Office of Stream Pollution Investigations of the Scientific Research Division of the Public Health Service has developed improved methods of laboratory procedure, has brought out correlation between aquatic life and stream pollution, and has set up limits for the bacterial content of raw water for various purification processes. The limiting numbers of Bacillus coli in Ohio River water, from which effluents can be produced consistently meeting the primary requirement of 1 B. coli per 100 cc. by various combinations of treatment are:

Character of treatment	*Limits of B. coli per 100 cc. Raw water*
(1) Chlorination alone	80
(2) Coagulation, sedimentation and rapid sand filtration	80
(3) Same as (2) with prechlorination	3,500
(4) Same as (2) with postchlorination	6,000
(5) Same as (2) with both pre- and post-chlorination	20,000
(6) Same as (4) with double stage sedimentation	60,000

The Office of Stream Sanitation of the Section of Engineering of the Domestic Quarantine Division made a study and report upon the Lower Chesapeake Bay which would serve as a guide for a demonstration of pollution abatement involving several states. It is intended, in the future, that like studies in coöperation with the states will be conducted by this office of the Domestic Quarantine Division, where-

as the Office of Stream Pollution Investigation of the Research Division will confine its attention almost entirely to purely research problems.

It appears to the writer that stream pollution abatement can best be stimulated by an arrangement whereby the federal government can assist the states in promotion of projects, coördination of state legislation, research to establish standards with respect to various water uses, stream investigations and financial aid. We have many examples where the outside viewpoint and promotion has overcome attitudes that certain expressed desires were personal rather than generally accepted professional viewpoints or that projects were being advocated for departmental aggrandizement.

(*Presented before the Indiana Section Meeting, April 8, 1936.*)

WATER METER CONSTRUCTION AND OPERATION

By F. A. Schaefer

(Gas and Water Superintendent, Public Service Company of Indiana, New Albany, Ind.)

The business of furnishing water to communities has slowly developed through the years from Biblical times until the present. Metering, as we understand it, was not thought of until very recently. This was due to the fact that the early methods of distribution did not require metering. About the beginning of the nineteenth century meters could have been used to good advantage, but, as in all development work, progress is slow and it was probably not until 1850 that water plant operators began to feel the need of meters badly enough to demand them. At this time, under modern methods of water distribution, waste was becoming a major factor. To curtail this waste meters were necessary or water would not be sufficient to supply the community needs.

"As recently, however, as 1891, there were 2,215,000 taps and only 165,000 water meters installed in the United States, or less than 7½ percent. Only 37 cities have as many as one-half their taps metered. Steadily since then, the use of meters has increased and by means of improved methods of construction and inspection a large part of former excessive water wastes have been salvaged."[1]

The history of water meter development in the United States might be of interest at this time. Mr. B. M. Stotter of Kansas City, Mo., has gathered some information on the history of meters which is quoted herewith:

"In all probability, some meters have been used since about the year 1850. The first meter I have any knowledge of being used was of the Duplex Piston type. In fact, we believe meters of this type are still manufactured, but are used principally for measurement of hot water, oil and other liquids, and are seldom used for cold water service. This type of meter was accurate, but quite heavy in construction, and expensive, and was later superseded by other types.

[1] Origin and Growth of Public Water Supply, by Perry Hopkins.

"Meters of the Rotary Piston type, such as the Crown, Union Rotary, Hersey Rotary, etc. were developed by the respective manufacturers beginning about the year 1878, and for 15 or 20 years thereafter, this type of meter was sold and used rather extensively.

"The Rotary Piston type of meter was also accurate, but more expensive than the Disc type later developed, and had the disadvantage of being rather expensive to repair, particularly if subjected to hot water or freezing.

"Beginning about the year 1890 and thereafter, a number of meter manufacturers introduced the Disc type meter. This meter gradually increased in favor, and in all probability at the present time, 90 percent of the meters in service in the United States are of the Disc type.

"About 1892, another water meter was placed on the market known as a Positive Displacement Oscillating Piston Meter. This type of meter is still largely used for measurement of cold water, and with suitable changes in its working parts, is also used for the measurement of hot water, gasoline, oil and other liquids.

"The above mentioned meters of the different types were made in sizes from ⅝-inch up and were not only used on domestic, but also on industrial services in the larger cities.

"About 1870 and thereafter, most manufacturers placed on the market a meter of the turbine or current or velocity type. These meters were usually manufactured in sizes 1½-inch and larger and were apparently designed to take care of industrial services requiring a large volume of water with the least possible friction loss through the meter. This type of meter is still largely used and is considered accurate within its maximum and minimum flow limits.

"About the year 1908 and thereafter, the Compound Meter was introduced to the water works trade. This meter being a combination of a current type to measure the large flows, with a small disc or piston type meter to measure the smaller flows, is especially adapted to services where the rate of flow varies over a 24 hour period from full capacity of the pipe down to very small streams. Compound meters are usually installed on such services as hotels, office buildings, apartment houses, etc.

"Other types of meters have also been placed on the market for installation on fire services, flow lines and other installations requiring the measurement of extremely large volumes of water with minimum friction loss.

"Assuming that water meters in this country came into use about 1850, for forty years thereafter, most of them were installed on other than domestic services, but as towns and cities obtained better water supply and were obliged in most cases to go to the expense of filtration or treating water in some other way, the need for meters on all services was gradually recognized.

"However, in the early days of the meter industry, there was a great deal of opposition to the use of meters, some of which was inspired by politics, some by ignorance and some by the fear that the use of meters would make water very expensive. This was during the time when you frequently heard the expression that "Water should be as free as air," and some even went so far as to claim that water meters would endanger the health of the community as it would provide a breeding place for germs, etc. However, the engineers who designed and built water works soon recognized the necessity of meters for

economical operation, and advocated their use. Beginning with the present century, the sale and installation of meters increased rapidly and while there are still some notable examples of cities not completely metered, it is not because such cities have demonstrated that meters would be of no advantage to them, but rather the reverse."

In Water Works Engineering on March 9, 1932, and again on June 29, 1932, the case of the water meter is argued. In the former article Alexandria, of our own state, is shown to have reduced pumpage, and pumpage costs and increased revenues by metering. In the latter article metering and other forms of waste control and elimination are advised rather than plant enlargement.

One hundred percent metering of our distribution systems has universal approval and great strides have been made toward this goal.

To accomplish still greater results in waste elimination more attention must be given to the accuracy of the meter over the wide range of flows it must handle.

We will pass by any criticism or suggestions for improvement on the present design of water meters, although I believe much can and will be done by the manufacturers in the future. Our problem is to take the equipment we now have and use it to its best advantage and we will be accomplishing much more than we now realize.

It has been my experience on the small properties of the company for which I work to find a lack of understanding, first, as to just what a meter is expected to do, and secondly, of how to repair it properly. Unquestionably large companies where their meter shops are under specialists who do nothing but handle meter problems feel that the methods practiced and the knowledge held by those of us operating medium sized properties is as far below their standards as ours are above our smaller brothers. If I accomplish no more than to have everyone here, who is not now doing so, send repaired meters out of their shop registering very accurately on a $\frac{1}{32}$-inch stream I shall feel that I have accomplished the purpose of this paper.

SMALL FLOWS

Why is it necessary to be so careful to have a meter register on a $\frac{1}{32}$-inch stream? Studies made clearly indicate all classes of customers use large percentages of water at very small flows. Well operated water systems in large apartment buildings where the superintendents take keen interest in their jobs find it difficult to eliminate all leakage.

It is, therefore, reasonable to expect the average domestic customer will have small leaks which go unnoticed.

A customer's meter indicating an average of 80 gallons of water per day was found to be actually using 180 gallons per day due to a small leak that the meter in service failed to register. So many instances of this kind have come to light that it is imperative to have meters test accurately on a $\frac{1}{32}$-inch stream. Our distribution losses would decrease and we would save money in two ways: by reducing pumpage and by increased revenue.

Just how does this small flow get by without being registered? That is the important thing we should know ourselves and impress upon our meter repairmen so that, after knowing how, they will take steps to remedy it. All meters coming into the shop for repairs should be checked. In most instances some wear will be apparent in the disc chamber and this wear must be given our greatest attention in the repair of meters.

Just how these small flows are under-registered is the important point to understand in meter repair work. It is to our advantage as operators to have a thorough knowledge of our small meters, so that we can teach or supervise our meter repairmen in the interest of better meter performance at the cheapest possible cost.

METER INSPECTION AND REPAIRS

All meters coming into our shops from customers premises are due some attention, the age of the meter naturally determining the course to pursue with each particular meter, age being considered as either years of service or quantity of water metered.

Water seepage and friction or a combination of both are the factors we shall consider in our study of the disc meter. These are the two enemies of extreme accuracy in our meters and both should be eliminated.

Loss in registration is likely to occur from leakage of the water at the following points:

1. Over the top of the disc ball.
2. Between the disc plate and measuring chamber walls.
3. Around the measuring chamber above or below the disc plate.
4. Through the thrust roller channel.
5. Between the halves of the measuring chamber.
6. Between the measuring chamber and outer casing.
7. Between the diaphragm and disc ball.

A thorough understanding on the part of the repairman of these points where small flows may pass unregistered will help him greatly in checking the meter undergoing repairs.

Many factors are responsible for our under-registration. Among them are:

1. Natural wear.
2. Foreign materials in the water metered.
3. Temperature extremes.
4. Defective materials.
5. Overloading.

The methods or types of repairs to the meter having one or more of the above conditions require the judgment gained from experience of the meter repairmen or yourself. Differences of opinion will be numerous as to just what to do with different makes of meters and also even in regard to the same makes. It is not my intention to carry this paper into such a controversial subject. I shall try to list only briefly the various ways of overcoming the failure. Obviously, a new meter, a complete measuring chamber and disc, or a new casing are to be considered in extreme failures, so the minor methods of repairs will only be included in the listings below.

1. To overcome leakage over the disc ball install:
   - A. New disc complete.
   - B. Bottom plate
   - C. Oversize disc balls and regrind.
   - D. Paper shims in disc balls.
2. Between the disc plate and measuring chamber:
   - A. Repairing #1 may be all that is necessary.
   - B. Install new disc complete.
3. Around the measuring chamber above or below the disc plate:
   - A. Free measuring chamber of foreign substances.
   - B. Make repairs to control block or top of spindle.
4. Through the thrust roller channel:
   - A. Fill in thrust roller channel and use special disc.
   - B. Refit channel and thrust roller.
5. Between the halves of the measuring chamber:
   - A. Fit together properly.
   - B. Replace distorted measuring chamber.
6. Between the measuring chamber and outer casing:
   - A. Fit together properly.
   - B. Replace distorted parts.

7. Between the diaphragm and disc ball:
   A. Replace disc ball.
   B. Replace diaphragm.

Under-registration from leakage only is fully covered above. Under-registration from friction obviously must be leakage of water at one of the points heretofore mentioned, but instead of the repairs being necessary in the disc chamber section of the meter they will require attention in the gear train, register, etc., except in the case of foreign matter in the measuring chamber. Ignoring where the by-passing of water takes place we shall endeavor to list the points of friction causing the under-registration and proceed in the same manner as above.

Friction in the parts mentioned below affect registration of small flows:

1. Register
2. Gear train
3. Stuffing boxes
4. Control roller and end of spindle
5. Disc chamber

Common causes of friction in a disc meter are:

1. Corrosion
2. Distortion
3. Improper or tight packing
4. Foreign substances

The register of a water meter is probably the weakest point in the construction of the meter. This is due largely to the fact that a register is subject to more abuse from more sources than the rest of the meter. This especially applies if the meter sits in a pit. Foreign substances are the most frequent cause of register failure. Broken glass frequently wedges between the numbered wheels and mutilated pinions or figure disc pinions of a direct reading register and the hands of round reading registers. Usually broken dial glasses are the result of impatience on the part of the meter reader because he cannot dislodge beads of "sweat." For this reason "sweating" should be given some attention by our meter shops. We believe we have helped this difficulty by drilling two $\frac{1}{8}$-inch holes in the register box. Grit may get into the register through a broken glass, by carelessness in failing to close register cover lid, and by muddy water covering the register and will cause the same damage as broken glass.

Corrosion is also an enemy of good register performance and is

hard to overcome. The design of the register and the quality of the materials used in its construction are the main factors effective against corrosion.

Many meters become "D.R." through register failure and we all have seen broken spindles and stripped gears. The force necessary to cause this is great. This evidence convinces me that many a meter is "braked" by friction in the register, but the force is not sufficient to snap a spindle and small flows surely can pass unregistered with this condition existing.

No register should pass through a meter shop without careful examination. Meters should be set in locations planned with utmost care, keeping in mind at all times the elimination of sweating and entrance of foreign materials into the register.

The Stuffing Box

Use packing washers made of materials of such quality that leakage is prevented and friction is kept to a minimum. Generally used and recommended are washers made of cork, rawhide or flexible composition sheet packing material. It is preferable that most packings be impregnated with a lubricant.

The Gear Train

Modern opinion favors oil enclosed gear trains designed in such a manner as to prevent the loss of lubricant from the gear case and also designed to avoid areas in which "dead" water will accumulate and freeze, thereby causing distortion. All undue friction is greatly overcome in such designed train gears. Open gear trains are susceptible to foreign substances in the water clogging the gears and to rapid corrosion especially from water containing corrosive properties.

Open gear trains should be replaced with oil enclosed. In view of opinions to the contrary, we then suggest that the gear train be thoroughly cleaned, worn parts renewed and oiled, and alignment checked. This should be done every time a meter is inspected internally.

Control Roller

Corrosion will cause the control roller to stick and the end of the spindle will rub with considerably more friction in its rotations than should the control roller have a roller bearing effect. Always examine and if necessary "free" the action of this roller.

Disc Chamber

Corrosive coatings on sides of disc chamber have a tendency to decrease small flow losses, but foreign substances and distortion causing actual jamming of disc against chamber walls will greatly increase small flow losses.

Friction has a "braking" effect on the operation of the meter which prevents smooth and easy action, which in turn increases small flow losses. In addition loss of pressure occurs. In the interest of accurate registration and good service an intelligent interest on the part of the meter repairman is necessary. Well trained meter repairmen may do much to avert water shortages and eliminate capital expenditures for additional pumping and purification facilities.

In conclusion, I have tried to be impartial in my remarks. If any manufacturers are represented I wish to say to them that after this winter's experience, if any of them can develop a meter which cannot be damaged by ice or bonfires in meter boxes and which contains a heating device to keep the meter and risers warm, they will be received with open arms.

(*Presented before the Indiana Section meeting, April, 7, 1936.*)

ELEVATED TANKS FOR WATER WORKS SYSTEMS

By Charles Brossman
(*Consulting Engineer, Lafayette, Ind.*)

The widespread use of centrifugal pumps in connection with the pumping of water to municipal plants, not only where purchased power is used, but at such places which generate their own power, has a very marked bearing on this subject.

On closed water systems, without elevated tanks, with centrifugal pumps in service, the pumps are usually installed large enough to take care of the peak loads. Usually in the smaller places one or more pumps of the same capacities are used. In such cases it is evident that with a pump available to take care of the peak and fluctuations in the load, on the lighter loads, especially at night, the pump being underload, drops off greatly in efficiency, as does the motor.

If we assume a pump operating at full load efficiency of 70 percent with a motor at 90 percent a combined efficiency of 63 percent results. This pump on the lighter loads, with a drop in efficiency of 50 percent, with the motor at 80 percent gives a combined efficiency of only 40 percent, a difference between the two of 23 points.

With such a condition, with the pump efficiency greatly reduced, over a considerable period of time, the power consumption will be greatly increased, over the year. In addition, if power is being purchased, with a maximum demand on the motor size, the rate will be increased due to this factor, for the pump must be large enough to take care of the peak load, with a corresponding increase in size of motor. Whereas, with an elevated tank, and pump operating uniformly, the pump size can be somewhat reduced, thereby reducing the demand factor.

Therefore, there is a disadvantage without the tank, in that if the pumping is direct, and if pressure is to be maintained at all times, the pumps must be large enough for this purpose, and their capacity must equal any demand that is put upon them.

Another disadvantage is that, if pump service is interrupted, pressure is lost immediately, which is always undesirable, especially if there is a fire.

With an elevated tank this would not occur. With a tank of reasonable capacity, an interruption to service could not jeopardize the fire fighting facilities, or cause complaint from other sources. Furthermore, any pump on the line can be used at its maximum output, and with a correspondingly maximum efficiency. Pumps, therefore, can be purchased, in the case with elevated tank service, at the maximum range of efficiency.

Another factor is the question of uniform pressure. With an elevated tank, automatic regulating control is available, whereby the tank variation in head may be kept within a few feet, thereby giving absolutely uniform pressures at all times.

Assuming the case of a closed system, without the tank, with a demand in outlying districts, the pipe friction load is built up and results in considerably lower pressure to such sections of the City. However, with an elevated tank, properly located, the friction loss is not usually so great and the water is always available in the tank.

On the financial side, the tank will act as an accumulator, and will even out the demand on the water and electrical end, with a consequent saving in the power for pumping.

It will give better fire fighting facilities, and at the same time give service in the case of electric outages, or breakdown of equipment.

The advantage, however, of saving in power cost is the most appealing. In practically all cases a considerable saving in power will result, and in many cases enough to pay off the equipment.

ALBION INSTALLATION

As an example, take the town of Albion, Indiana, with a water consumption of approximately 50,000 gallons per day and a population of 1100. An elevated tank was installed with P.W.A. funds at a total cost approximately $7,200.00. The power used before installing this tank, on the closed system, was approximately 1 KWH for 530 gallons; after the tank was installed, pumping was approximately 1 KWH for 1050 gallons, thus cutting power consumption in half.

In this particular case, a grant under P.W.A. was given to the town. The town's portion of 70 percent to be paid off was $5,040.00. With 4 percent interest on Government money, the tank would be paid off in from 15 to 16 years by the saving in power alone, at the present rate of consumption. Actually, we have figured that it will be paid off in less time than this.

These, of course, are approximate figures, and do not allow for any

depreciation, but simply take into account interest and principal and a saving in power.

Albion, has its own generating plant, and the total cost of power is considered at 3 cents per KWH, including all costs. A careful check on all costs and power used on equipment is being kept by Mr. Ed. Maloney, superintendent of the plant, and the records show this investment is well justified.

The electric pump used in this system is only 200 GPM. In case of fire a steam pump must be operated and steam was kept on the steam equipment at all times, before installing the tank. Now that the elevated tank is installed, it is not necessary to keep steam directly on these pumps, although steam is always available from the main light plant. However, the fact that the steam may be kept off the pumps and the lines leading to the pumps, also results in a saving in fuel, which has not been taken into account in the computations given.

GOSHEN INSTALLATION

At the city of Goshen, Indiana, we have recently installed a 500,000 gallon tank. The old plant was steam driven. About six years ago, the city installed a modern Diesel lighting plant, but only two of their deep well pumps were electrified at that time. The boilers had to be kept going at all times in the old steam plant, in order to have available suitable fire protection. In this case, also, a P.W.A. loan was negotiated with the Government through Mayor Clell E. Firestone, and the entire water works system has been electrified. The city now has eight electric driven deep well pumps, and a new half million gallon tank. The loan was negotiated on the basis of the savings which would be made by abandoning the steam plant.

The cost of pumping for the old system on which boilers had to be kept up at all times, was given at approximately 8.3 cents per thousand gallons, which of course, was high, but the equipment was old, and used air lift pumps and double pumping, except for the two electric driven pumps

The actual electrical pumping cost would be in the neighborhood of 1.2 cents per thousand gallons, and total cost 2.2 cents per 1000 gallons. To realize this, a new elevated tank had to be installed.

The old standpipe was not adequate for the demands, as the upper portion of this standpipe did not store very much water. The new elevated tank, of one-half million gallons, was installed some distance from the plant and on the opposite side of the city.

The entire pumping equipment is automatically controlled. Two automatically controlled pumps operate at the tank site, which is about one and one-half miles away from the main station, and six

TABLE 1

Estimated savings to be effected by proposed construction in Goshen, Indiana—using all electric pumps and new elevated tank

	COSTS BEFORE PROPOSED CONSTRUCTION, FROM CITY'S RECORDS	COSTS AFTER PROPOSED CONSTRUCTION, ESTIMATED
Boiler Room and Steam Pumping		
Labor	$4,669.83	
Fuel	7,776.86	
Water	219.04	
Supplies and Expenses	944.72	
Maintenance of Equipment	465.91	
Maint. of Bldgs., Fix. & Gds	2.97	
Labor-Superintendent & Chief Engineer	4,839.75	$1,140.00
Pumping Station Supplies & Expenses	877.59	
Labor Operating Electric Pumps	Incl. above	1,260.00
Supplies & Expense Operating Electric Pumps		350.00
Maintenance of Pumping Station Equipment	89.06	173.39
Maintenance of Bldgs., Fixtures and Goods Pumping Station	977.71	
Power for Electric Pumping	3,167.55	3,504.00*
	$24,030.99	$6,427.39

Unit Costs

Water used estimated at 800,000 gallons per day.

Cost based on 1100 gallons per KWH @ 1.3 cents per KWH = 1.2 cents per 1000 gallons (approximate)

800,000 gallons @ 1.2 cents = $9.60 per day power = $3504.00 per year (power only)

Costs estimated by Chas. Brossman

Total cost per steam pump $24,030.99 per year or 8.3 cents per 1000 gallons

Total cost per electric pump $6,427.39 per year or 2.2 cents per 1000 gallons

* Saving in electric current. With all electric pumping due to larger consumption, a lower rate is possible.

automatically controlled deep well pumps at the main station, each pump having a capacity of 500 g.p.m. Any pump can be started or stopped by push button control from the main plant.

Mr. Merle J. Miller, superintendent and manager of the plant, after the new system was in operation states as follows in a letter:

For your information on the water system, it is much more satisfactory. With a standpipe or elevated tank with the small capacity that we had previous to the erection of our new elevated tower, our water circuits were only fairly stable, but since the additional storage capacity has been added to our system, it has made a wonderful change in our water pressure charts as there is more cushion and no surge anywhere along the line. A number of charts taken at the elevated tower location have been absolutely perfect from the standpoint of surges or variation in pressure. We found before, especially with the steam pumping equipment, that we were troubled with a constant surging, especially in the further ends of our circuits. If you were to listen closely, you would be able to detect each pulsation of the steam pump, as our standpipe capacity, at that time, was not enough to cushion the whole system properly. Comparing the old system with the new for uniform pressure, there is a vast difference. With the old system we had as much as five pounds deflection in pressure, while in the new system, if given any attention at all, a chart is obtained of uniform pressure with as little a variation as one pound.

We also find with the connecting of the dead ends that it is easier to carry a more uniform pressure than it was before. It has made a wonderful difference in the circulation of the water in districts where we had frequent complaints during the warm summer months of having warm stagnant water. The citizens living in those districts have expressed themselves as being very much satisfied with the difference that it has made in the drinking water qualities."

From the foregoing, it will be seen that for any plant that does not have an elevated tank, or has a standpipe of very small capacity, with very little water available in the upper section, the modern type of elevated tank with all of the storage at the proper level will almost invariably result in a financial saving, as well as in other advantages which accrue to it. Such an installation, or course, requires its own special study, to determine the size. In determining this size, account should be taken not only of the domestic consumption, but of the fire demand. The size of the tank will, therefore, depend somewhat upon the other storage facilities, such as ground level reservoirs, as well as the total available pumping capacity from wells, or other sources of supply. The size of the tank should be predicated upon domestic consumption and a maximum fire demand to meet the Fire Underwriters requirements over the duration of the fire period.

FIRE PROTECTION

Elevated tank storage is given more credit by the Underwriters than ground storage, as it is always available for pressure.

The relation of the elevated tank to fire protection is one of the important factors that should not be lost sight of. Modern elevated tanks, as compared to old standpipes, are much different, for the available capacity for fire fighting facilities, as credit for water in a standpipe, is only allowed for the top sections. Modern tanks, as now designed, keep the water level to within a few feet variation, dependent more or less upon type of regulating control for the electric pumps.

In the installation of elevated tanks, it should be endeavored to keep the tank large enough to meet, as near as possible, requirements of the Fire Underwriters.

Fire flows should not be confused with the total daily flow or capacity, for instance: if a town has a total available supply and storage based on a 24 hour period the fire flow will usually be based on a 5 hour flow for towns of 2500 and less, which would mean that they would get 4.8 times the available storage capacity for fire. For cities over 2500 the multiplier will be 2.4 times the storage, which is based on a 10 hour fire flow period.

The GPM fire requirements for the average city are given by the Underwriters, as follows:

Population	*Required fire flow, g. p. m.*
1,000	1,000
2,000	1,500
4,000	2,000
6,000	2,500
10,000	3,000
13,000	3,500
17,000	4,000
22,000	4,500
28,000	5,000
40,000	6,000
60,000	7,000
80,000	8,000
100,000	9,000

The above table gives the amount of fire flow recommended by the Underwriters. In selecting the tank, the fire flow for the period required, according to population, must be considered and to this must be added the domestic consumption.

This amount is balanced against the available low lift capacity of the pumps, such as wells or filters, and the ground storage capacity. The total low lift and ground storage capacity is then determined.

The second step is to figure the high lift pump capacity and the elevated storage capacity.

After these two quantities are known, they are compared with the required fire flow and domestic flow over the 5 or 10 hour period, as the case may be. This will then give the ideal condition for getting the pump and tank capacities respectively. This is not always met, but should be wherever possible.

In case these conditions are not met, if there is a deficiency in pumping capacity or storage on either the low lift and ground storage or high lift and elevated storage, this deficiency will be taken into account in the making of rates. In other words, there should always be reserve in both the low and the high lift pumpage capacity.

It should be clearly kept in mind that the total 24 hours available capacity is not what is used by the Underwriters. They base the capacity on the fire flows for a certain period of hours, as given above and which gives a larger figure than the actual 24 hour period.

As there are many factors entering into the amounts required as related to deficiency, factors for the Underwriters estimates, it is not thought desirable to enter into a technical discussion, except to give the salient points to be considered in the grading of a system of fire protection.

The matter of pressure from elevated tanks should not be lost sight of, as certain pressures are required for certain types of buildings, according to the size of town and the construction therein. These pressures should be determined together with the friction losses through mains, in order to get the proper height of tank to give the required pressure.

INDIANAPOLIS TANK

One of the outstanding tank installations in this state, is that installed by the Indianapolis Water Company for the east section of Indianapolis, under the direction of W. C. Mabee, Chief Engineer.

This tank is located in the eastern section of Indianapolis, approximately 100 feet higher than their main pumping station. With this long line of pipe, and the ensuing friction losses, pressures were very low in this district. An elevated tank with $1\frac{1}{2}$ million gallons capacity, serving approximately 64,000 people in this district, has resulted in great improvement in pressure and supply, with satisfaction to the water consumers.

This tank is the largest one in the state of Indiana on a city water supply. It is 72 feet to the bottom, and with this large capacity, has a range of only 25 feet between the upper and lower water levels.

(*Presented before the Indiana Section meeting, April 8, 1936.*)

A COMPARATIVE STUDY OF CERTAIN PRESUMPTIVE MEDIA FOR TESTING RAW WATERS[1]

By Ralph L. France

(Massachusetts Agricultural Experiment Station, Amherst, Mass.)

The Standard Methods procedure (1) for the bacteriological analysis of both treated and untreated water supplies has for several years been subjected to a heavy barrage of criticisms from sanitarians and water bacteriologists. These criticisms have for the most part been centered upon the use of lactose broth as a presumptive medium, and the use of the coli-aerogenes group rather than fecal Bact. coli as the index of pollution.

Winslow (2) has continually emphasized both in print and in discussion at scientific meetings that the practical interpretation of results obtained with any procedure should be based on common sense. Whether medium A will recover 75 coli-aerogenes organisms per cubic centimeter while medium B will recover 100 coli-aerogenes organisms per cubic centimeter is not the important factor from the standpoint of practical interpretation. The important factor is that both media will recover sufficient coli-aerogenes organisms to indicate that the water under test is in an insanitary condition. Any attempt to split hairs as to the actual number of coli-aerogenes bacteria that different media will recover from water is not of practical significance to the sanitarian provided the media recover sufficient organisms to condemn the water. Dr. Winslow does not intend to imply that research endeavors to originate better methods and media should be discouraged; to the contrary, he enthusiastically encourages these endeavors. What he does intend to emphasize is that common sense must be exercised in the interpretation of results regardless of the methods used, provided those methods are scientifically sound.

However, there are certain phases of the bacteriological analysis of water in which the technician is interested in the total number of coli-aerogenes organisms present in the water under test. In such a study

[1] Published as Contribution No. 240, Massachusetts Agricultural Experiment Station.

it is desirable to use the medium that will recover the highest possible number of coli-aerogenes organisms from any given water. Studies of sewage beds, stream pollution, waters over oyster beds, and possibly bathing beach waters, are examples of this type of testing. In the last edition of "Standard Methods of Water Analysis" (7th edition, 1933), there are included the formulae for certain recently devised media with the request of the Committee on Standard Methods that comparative studies be made with these media and the Standard media with the intention of accumulating sufficient data to evaluate the relative efficiency of these media under routine testing conditions. The present report gives the results of such a comparison made on 76 samples of raw polluted brook water. The samples were made available during a recent study of stream pollution in the Town of Amherst, Massachusetts.

MEDIA AND METHODS

The presumptive media used in this experiment were standard lactose broth, brilliant green bile broth (hereafter designated as B. G. B. broth), and methylene blue erythrosine brom cresol purple broth (hereafter designated as B. C. P. broth). All media were prepared according to the directions given in "Standard Methods of Water Analysis" (1). The so-called "parallel tubing" method of inoculation was employed. Five 10 cc., five 1 cc., five 0.1 cc., five 0.01 cc., and five 0.001 cc. amounts of each sample of water were inoculated into the corresponding number of tubes of each medium. Thus, 25 tubes of each medium were used for each sample of water, making a total of 1900 tubes of each medium used in testing the 76 water samples. Keeping the same number of tubes of each medium gave a common figure for the basis of comparison.

All positive gas tubes were *completely* confirmed by the Standard procedure. While it is not the practice in routine water analysis to confirm the 24-hour positive gas tubes when untreated water is being tested, nevertheless, it was felt that in this type of comparative study the added information would be of value in interpreting the results. Further, all positive lactose broth tubes were additionally confirmed by inoculation into secondary tubes of B. G. B. broth. This is a variation of the procedure recommended in Standard Methods (see page 129) for untreated waters. In this procedure gas production in these secondary tubes within 48 hours is considered sufficient evidence of the presence of members of the coli-aerogenes group. It was felt

advisable in this study to check this procedure, so all positive secondary B. G. B. broth tubes were completely confirmed by the Standard procedure.

RESULTS

Table 1 gives a detailed summary of the results obtained during the first 24 hours of incubation. All percentage figures given in this table, and tables 2 and 3, are based on the total number of tubes inoculated in each case and not on the total number of positive gas

TABLE 1

Detailed summary of results obtained during first 24 hours of incubation

AMOUNT OF INOCULUM	LACTOSE BROTH								B. G. B. BROTH				B. C. P. BROTH			
	Gas		Confirmation S. M.		Confirmation Sec. B. G. B. Gas		Confirmation Sec. B. G. B. + S. M.		Gas		Confirmation S. M.		Gas		Confirmation S. M.	
	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent
cc.																
10	340	90	298	78	340	90	326	86	360	95	325	86	266	70	267	70
1	286	75	237	62	283	74	271	71	297	78	277	73	134	35	98	26
0.1	191	50	156	41	188	49	184	48	181	47	172	45	29	7.6	23	6.1
0.01	51	13	40	10.5	51	13	50	13	48	12	41	10.8	3	0.8	3	0.7
0.001	5	1.3	4	1.1	5	1.3	5	1.3	6	1.6	5	1.3	1	0.3	1	0.3
Totals...	873	46	735	39	867	46	836	44	892	47	820	43	433	23	392	21

S. M. = Standard Methods procedure for complete confirmation.
Sec. B. G. B. = secondary tubes of brilliant green bile broth.

tubes. A true comparison of the results can be drawn only when a figure common to all the media under study is used as the basis for computing the percentage figures. For the readers who are interested in knowing the percentage of confirmations as based on the total numbers of positive gas tubes, table 4 has been included to supply this information, but it will not be discussed in the text.

Of the total 1900 tubes of lactose broth inoculated with the various portions of water from each of the 76 samples, 873 gave ten per cent or more of gas within the first 24 hours of incubation. Of a similar number of primary B. G. B. broth tubes inoculated, 892 gave a posi-

tive presumptive test within the first 24 hours of incubation, and of the total 1900 B. C. P. broth tubes inoculated only 433 gave a positive presumptive test within the first 24 hours of incubation. It will be observed from this that the B. G. B. broth gave the highest number of positive presumptive tests during this incubation period, although the total is only slightly higher than that obtained with the Standard lactose broth.

When all these positive gas tubes were completely confirmed by the Standard procedure, 820 confirmations were obtained from the

TABLE 2

Detailed summary of results obtained during the 24–48 hours incubation period

AMOUNT OF INOCULUM	LACTOSE BROTH								B. G. B. BROTH				B. C. P. BROTH			
	Gas		Confirmation						Gas		Confirmation S. M.		Gas		Confirmation S. M.	
			S. M.		Sec. B. G. B. Gas		Sec. B. G. B. + S. M.									
	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent
cc.																
10	31	8.2	20	5.3	28	7.4	28	7.4	12	3.2	10	2.6	90	23	66	17
1	57	15	39	10.3	44	11.6	41	10.8	51	13.4	31	8.2	151	40	108	28
0.1	69	18	39	10	50	13	43	11	68	18	48	12	103	27	80	21
0.01	45	12	25	6.6	36	9.5	28	7.4	21	5.5	10	2.6	29	7.6	25	6.6
0.001	11	2.9	3	0.8	4	1.1	4	1.1	6	1.6	4	1.1	2	0.5	2	0.5
Totals...	213	11.2	126	6.6	162	8.5	144	7.6	158	8.3	103	5.4	375	19.7	281	14.8

S. M. = Standard Methods procedure for complete confirmation.
Sec. B. G. B. = secondary tubes of brilliant green bile broth.

primary B. G. B. broth tubes, 735 confirmations from the lactose broth, and but 392 confirmations were obtained from the B. C. P. broth.

However, when secondary tubes of B. G. B. broth were used to confirm the positive lactose broth tubes, and gas formation within 48 hours of incubation accepted as sufficient confirmation of the presence of members of the coli-aerogenes group, 867 confirmations were obtained. This gave a somewhat higher number of confirmations than that obtained from the primary B. G. B. broth tubes. When the positive secondary B. G. B. broth tubes were confirmed by the

Standard procedure, 836 of the 867 positive tubes revealed the presence of members of the coli-aerogenes group. This figure is still slightly higher than the total obtained from the primary B. G. B. broth tubes. These results indicate that the Standard Methods procedure gave a much higher number of false presumptive tests during the incubation period than did the primary B. G. B. broth, or the lactose broth plus confirmation by secondary tubes of B. G. B. broth.

Table 2 gives a detailed summary of the results obtained during

TABLE 3

Detailed summary of results obtained during the entire 48 hours incubation

AMOUNT OF INOCULUM	LACTOSE BROTH								B. G. B. BROTH				B. C. P. BROTH			
	Gas		Confirmation S. M.		Sec. B. G. B. Gas		Sec. B. G. B. + S. M.		Gas		Confirmation S. M.		Gas		Confirmation S. M.	
	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent	Number positive	Percent
cc.																
10	371	98	318	83	368	97	354	93	372	98	335	88	356	94	333	88
1	343	91	276	72	327	86	312	82	348	91	308	81	285	75	206	54
0.1	260	68	195	51	238	63	227	60	249	66	220	58	132	34	103	27
0.01	96	25	65	17	87	23	78	21	69	18	51	13	32	8.3	28	7.1
0.001	16	4.2	7	1.8	9	2.3	9	2.3	12	3.2	9	2.3	3	0.7	3	0.7
Totals..	1086	57	861	44	1029	54	980	52	1050	55	923	49	808	43	673	35

S. M. = Standard Methods procedure for complete confirmation.
Sec. B. G. B. = secondary tubes of billiant green bile broth.

the 24 to 48 hours incubation period. There was a total of 213 positive presumptive tests obtained with the lactose broth, 158 with the primary B. G. B. broth, and 375 with the B. C. P. broth. This last figure would seem to indicate that some factor, or factors, in the B. C. P. broth retarded the growth, or gas production of the coli-aerogenes organisms present in the tubes.

When the Standard procedure for complete confirmation was applied to all these positive gas tubes, 126 confirmations were obtained from the lactose broth, 103 confirmations were obtained from the primary B. G. B. broth, and 281 confirmations were obtained

from the B. C. P. broth. These results show that a very high number of false presumptive tests were obtained with each of the media under study. The reason for this is probably the Standard procedure of confirming all presumptive tubes that show any gas whatsoever during this period. A large number of the tubes that showed less than ten per cent of gas failed to reveal the presence of members of the coli-aerogenes group.

When the positive lactose broth tubes were confirmed by inoculation into secondary tubes of B. G. B. broth, 162 of the 213 positive lactose broth tubes showed gas formation within 48 hours of incubation in these secondary tubes. Confirmation of these positive secondary B. G. B. broth tubes by the Standard procedure resulted in 144 of the tubes showing the presence of members of the coli-aerogenes group.

Table 3 gives a detailed summary of the results obtained during the entire 48 hours of incubation. It will be observed that 1086 positive presumptive tests were obtained with the lactose broth, 1050 positive presumptive tests with the primary B. G. B. broth, and only 808 positive presumptive tests with the B. C. P. broth.

When the Standard procedure for complete confirmation was applied to all these tubes, 861 confirmations were obtained from the lactose broth tubes, 923 confirmations from the primary B. G. B. tubes, and only 673 confirmations from the B. C. P. broth.

However, when secondary tubes of B. G. B. broth were used to confirm the positive lactose broth tubes, and gas formation within 48 hours of incubation accepted as sufficient evidence of the presence of members of the coli-aerogenes group, 1029 of the 1086 positive lactose broth tubes gave a positive confirmation. When these positive secondary B. G. B. broth tubes were themselves confirmed by using the Standard procedure, 980 of the tubes showed the presence of members of the coli-aerogenes group.

DISCUSSION

There are several observations to be made from this study. In the first place, the author wishes to make it clearly understood that he makes no application of these results to finished waters. It was stated in the introduction to this report that this study was made on raw polluted brook waters. The writer agrees with Winslow that in testing finished waters the important factor in the practical application of the interpretation of results is not necessarily the total numbers

of coli-aerogenes present, but rather whether there is a sufficient number of these organisms to indicate the insanitary condition of the water. Any scientifically sound procedure that would reveal this fact is satisfactory from the standpoint of the sanitarian. However, from the standpoint of the technician studying stream pollution, sewage disposal, or waters over oyster beds, the total numbers of coli-aerogenes organisms present in the water under test is the important factor. It is on this basis that the results given in this report will be discussed.

In table 3 it will be observed that the lactose broth gave the highest total number of positive presumptive tubes. However, the difference between this total and that obtained with the primary B. G. B. broth was rather small in comparison to the totals. The B. C. P. broth gave such a low total number of positive presumptive tests and confirmations that for this type of analysis it cannot be compared with the other media. In confirming the positive lactose broth tubes and the positive primary B. G. B. broth tubes by the Standard procedure it will be observed that the primary B. G. B. broth appeared to be a more efficient presumptive medium than the lactose broth. There was a total of 923 confirmations obtained with the primary B. G. B. broth as against a total of 861 confirmations with the lactose broth. These results show that a much higher number of false presumptive tests was obtained using the Standard Methods procedure than with the primary B. G. B. broth as a presumptive medium and the Standard procedure for complete confirmation. This would seem to indicate that either the concentration of bile or the concentration of brilliant green in the B. G. B. broth served to inhibit the growth of extraneous bacteria which in the standard lactose broth were encouraged to grow, possibly in many cases to the extent of considerably outnumbering the coli-aerogenes organisms. This heavy growth of extraneous bacteria in the lactose broth tubes probably masked the presence of members of the coli-aerogenes group when material from the tubes was streaked on Endo or E. M. B. plates. This is supported by the fact that when secondary tubes of B. G. B. broth were used to confirm the positive lactose broth tubes, a much higher number of confirmations was recorded. Confirmation of these positive secondary B. G. B. broth tubes revealed that in 95 percent of the cases coli-aerogenes organisms were present in large numbers in the tubes. This high percentage of confirmation would seem to justify the acceptance of gas formation in the secondary tubes

within 48 hours of incubation as an indication of the presence of members of the coli-aerogenes group.

Another important observation to be noted from these results is that the so-called "parallel tubing" method of testing untreated waters was not a satisfactory procedure. Of course from the theoretical standpoint this method is fallacious for it assumes that the same water is being placed in both the lactose broth tube and the primary B. G. B. broth tube of each pair. Further, this method assumes that gas formation in any primary B. G. B. broth tube is sufficient confirmation of the presence of members of the coli-aerogenes group in that tube. In table 3 it will be observed that from a

TABLE 4

Summary of the percentage of confirmations

Percentages are based on positive presumptive tests

AMOUNT OF INOCULUM	LACTOSE BROTH			B. G. B. BROTH	B. C. P. BROTH
	S. M.	Sec. B. G. B. Gas	Sec. B. G. B. + S. M.	S. M.	S. M.
cc.					
10	86	96	95	90	91
1	80	95	91	89	72
0.1	75	92	87	88	78
0.01	68	91	81	74	88
0.001	44	56	56	75	100
Totals....	79	95	90	88	83

S. M. = Standard Methods procedure for complete confirmation.
Sec. B. G. B. = secondary tubes of billiant green bile broth.

total number of 1050 positive primary B. G. B. broth tubes only 923 tubes were confirmed by the Standard procedure for the presence of members of the coli-aerogenes group. This appears to the author to be too high a percentage of false presumptive tests to justify such a procedure for this type of testing.

Considering this parallel tubing method further in this respect, it will be observed that the use of lactose broth with secondary tubes of B. G. B. broth for confirmation gave a much higher total number of recoveries of the coli-aerogenes group than did the primary B. G. B. broth with the Standard procedure for confirmation. This would seem to indicate that the use of parallel tubes of B. G. B. broth as presumptive media is unnecessary from the standpoint of the results

obtained. In fact, they might lead to erroneous results. The time and materials used, and their cost, are a considerable item in routine testing, and if this could be eliminated without detracting from the accuracy of the results, it would be an important fact to consider. The results obtained in this study indicate that these tubes could be eliminated without detracting from the accuracy of the results.

The use of lactose broth with confirmations of all positive presumptive tubes by inoculation into secondary tubes of B. G. B. broth gave the highest total number of recoveries of the coli-aerogenes group from the raw waters tested in this study. The results indicate that this method might give the most satisfactory results when testing raw polluted waters.

REFERENCES

(1) Standard Methods of Water Analysis, 7th Ed., 1933.

(2) WINSLOW, C.-E. A.: Standard Methods and new procedures for the isolation of colon bacilli from water. Amer. Jour. Pub. Health., 24, 5, 456–469.

PROBLEMS IN COAGULATION AND CORRECTIVE TREATMENT

By Edward S. Hopkins

(*Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.*)

Until recent years mixing basin design has been empirical, due largely to the fact that insufficient chemical engineering data were available regarding the characteristics of floc formation in its relation to time and velocity of mixing. Agitation from 15 to 30 minutes at a velocity between 1 and 1½ feet per second is necessary to produce good floc (7) in a baffled basin. Mechanical stirring requires about 40 minutes for comparable coagulation, when the initial paddle has a velocity of 2 feet per second and the last one in the series maintains a flow just sufficient to keep the floc in suspension. If this basic datum is accepted, it is at once apparent that much of the troubles experienced with poor floc formation is caused by an insufficient mixing period, since most basins in service have adequate velocities.

Assuming that the correct concentration of coagulant is used and that the pH is adjusted to the proper value, coagulated floc is a dense, compact material with well distributed silt particles throughout the mass and settles readily.

An initial rapid velocity followed by a progressively decreasing speed will produce the most compact floc (4). A baffled basin having the same width of channel in all portions, or a paddle installation at equal speeds, does *not* produce the best coagulation. The diagram in figure 1, illustrates a "round the end" baffled basin designed in accordance with these newer principles. The fundamental data for this design were obtained with the laboratory stirring device under carefully controlled conditions and the rapidity of floc sedimentation was used as the criterion of good coagulation.

In structural detail this design is a modification of the conventional basin as to ratio of over all dimensions and width of final passages. There are 36 channels arranged as follows:

The first 7 are 3 feet wide
The next 3 are 4 feet wide
The next 9 are 5 feet wide
The next 7 are 6 feet wide
The next 10 are 7 feet wide

or the initial one-third of the basin has a velocity three times that of the final passage and the center portion velocity is twice the final. Each increment merges into the other so as to provide a gradual retarding of the speed. A similar operating scheme can be applied to a mechanical basin by varying the speeds of the paddles in regular sequence.

The efficiency of a mixing basin is easily lost if the outlet gates and tunnels create a greater velocity than that of the last channel in the basin. Under these conditions the higher speeds will break the floc into small particles resulting in greatly delayed and poor sedimentation.

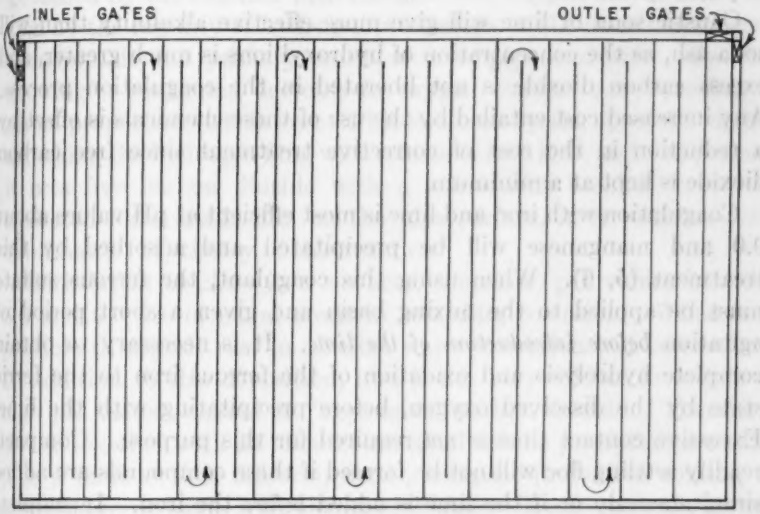

FIG. 1

The correct dosage of coagulant is easily determined by a stirring test, the so called "jar test." This should be done with a mechanical device since hand stirring or shaking *cannot be duplicated* and will give erratic results in successive experiments. Tests made with mechanical agitation will check. Elaborate devices are not necessary, any simple machine, made from spare parts if necessary, is adequate. Such a device is invaluable, not only to estimate the dose of coagulant, but also to determine the correct addition of alkali for the maintenance of proper pH values in the basin.

Under average operating conditions the pH values normally found

produce satisfactory coagulation. However, with low alkalinity or under flood conditions with rapid changes in turbidity and pH values, many plants find it necessary to use alkali to obtain good floc formation. The rapidity of change together with the masking of the indicator color by suspended material will give erratic plant control if reliance is placed upon the usual "spot" colorimetric tests. At the time of greatest need the plant operator is faced with an unsatisfactory method of control.

The development of the antimony electrode having a pH range from 3.0 to 12.0, has made available the utilization of the recording potentiometer over any range of hydrogen ion concentration encountered in plant operation.

Caustic soda or lime will give more effective alkalinity than will soda ash, as the concentration of hydroxyl ions is much greater, and excess carbon dioxide is not liberated in the coagulation process. Any increased cost entailed by the use of these chemicals is offset by a reduction in the cost of corrective treatment since free carbon dioxide is kept at a minimum.

Coagulation with iron and lime is most efficient at pH values about 9.0 and manganese will be precipitated and adsorbed by this treatment (5, 6). When using this coagulant, the ferrous sulfate must be applied to the mixing basin and given a short period of agitation *before introduction of the lime.* It is necessary to obtain complete hydrolysis and oxidation of the ferrous iron to the ferric state by the dissolved oxygen, before precipitating with the lime. Excessive contact time is *not* required for this purpose. Compact, readily settling floc will not be formed if these compounds are added simultaneously or if the lime is added *before* the iron. Incomplete mixing after addition of the alkali will produce "pin head" floc or other types of poor coagulation.

CORRECTIVE TREATMENT

Submission to the public of a water analysis sheet showing a controlled corrective treated water, fairly uniform in composition is a factor of industrial value to the community. No natural water would be satisfactory to *all* users in any city and if treated to remove the constituent objectionable to some industries, it would still be objectionable to others.

Without consideration of the possible future use of non-corrosive metals or pipe lining for distribution systems, reduction of corrosion

in existing mains can most satisfactorily be accomplished only by the treatment of the water. Complete elimination of corrosion is not obtained in this manner, but the economic value of the reduction generally exceeds the cost of treatment.

A study of the fundamental reactions governing cold water corrosion demonstrates, as shown by Speller (13), that iron will dissolve in natural waters with the production of atomic hydrogen sufficiently fast so as to keep a film of it at the surface of the metal. Therefore, the rate of pipe corrosion is controlled by the reaction of the dissolved oxygen with the hydrogen to form water or by the production of molecular hydrogen. In neutral or alkaline solution, corrosion is governed by the reaction with the dissolved oxygen and in acid solution by the rapidity of hydrogen production. The dissolved oxygen, therefore, is the primary cause of iron pipe corrosion. Systems showing a continued decrease in oxygen content are corroding in direct proportion to this loss. This is caused by the dissolved oxygen attacking the hydrogen film, with release of iron ions, and also because it sets free carbon dioxide with a subsequent breakdown of the hydrated ferric oxide film on the pipe surface, in accordance with Whitman's (14) theory of this reaction.

With *bright* or *clean* iron surfaces, therefore, pH values between 5.0 and 9.0 are of equal merit in retarding corrosion. When it is possible to deposit rust in alkaline water, corrosion will be checked. In addition to this deposition, iron is not very soluble in waters of high pH values, devoid of "aggressive" carbon dioxide. Therefore, if rust together with an alkaline material can be precipitated on the pipe a more or less uniform, dense, compact protective coating of hydrated ferric oxide and calcium carbonate will adhere to the metal. This coating will exclude the diffusion of the dissolved oxygen to the metal and also insulate the corroding solution from its surface. To control corrosion in water pipes, since oxygen cannot be removed, it is necessary to eliminate the factors causing a breakdown of this protective coating. "Aggressive" carbon dioxide is the most common factor found in natural waters since it dissolves this "egg shell" thickness coating.

Corrective treatment with lime to remove "aggressive" carbon dioxide and retard cold water corrosion has been continuously practiced at Baltimore since 1922. Contrary to experience elsewhere, no reduction in pH value has been found in the distribution system which consists of about 1,500 miles of pipe lines and 7 open balancing

reservoirs arranged so that 3 of them receive water from the others which are directly fed from the plant. An average pH value of 7.8 was maintained in the water leaving the plant. Since 1931 weekly samples have been collected from 27 different stations on the system and during this period the pH value has not averaged below 7.6 at any point in the city (9).

To determine if adequate cold water protection is being given, a study of the corrosive properties of the water in the pipe systems of two large office buildings was undertaken, collecting weekly samples over a period of 11 months. Both are about 6 miles distant and on direct services from the plant. One was about 3½ years old with no corrosion in the lines and the other about 28 years old with encrusted pipe. Analytical data over this period disclosed that in the newer building, the pH and dissolved oxygen were unchanged and that iron

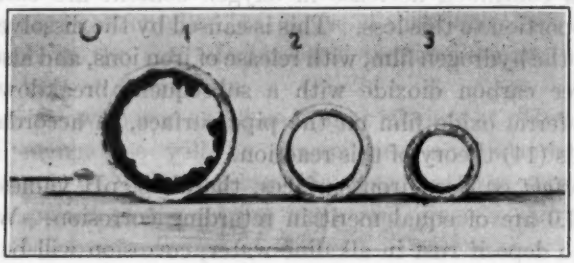

FIG. 2. PIPE TAKEN FROM DISTRIBUTION SYSTEM, BALTIMORE, MARYLAND

was not dissolved. In the older building, a slight increase, 0.01 ppm., in soluble iron was obtained with a corresponding loss in dissolved oxygen of 0.4 ppm., although the pH value, 7.6, remained constant. These results indicate a slight corrosion in the older building with immediate precipitation of the insoluble hydrated ferric oxide by the alkaline water. The practical value of this corrective treatment is shown by the pipe specimens in figure 2, which were obtained from the services supplying this territory.

A very soft, low alkalinity water, will have such slight buffer action that maintenance of the hydrogen ion concentration on or just below the Baylis calcium carbonate equilibrium curve, will produce caustic alkalinity. This is borne out by Hale's (1) recent work with the soft Catskill supply for New York City, which indicates that in general practice excess lime hydrate treatment would not be accept-

able for industrial use. In some instances it will be impossible to adjust the pH value to the curve unless artificial buffers are added.

Coatings deposited in the pipes must contain calcium carbonate in a ratio of 0.1 part as Ca to 1 part of Fe, if excess corrosion and pitting are to be checked. This indicates the necessity of constantly maintaining the water at the calcium carbonate equilibrium point. The decrease in pH values found in the outlying portions of many distribution systems is probably caused by erratic control of the lime application or because the maintenance of sufficiently high pH values would produce caustic water. The example cited by Hechmer (2) is characteristic. The pH value leaving this plant was about 7.4 with 6.6 at the end of the line. This is below the calcium carbonate equilibrium point, which in accordance with the curve should be about 8.5. Removal of all "aggressive" carbon dioxide is impractical as it would probably produce caustic alkalinity. This inability to remove the carbon dioxide explains the continuance of corrosion in the pipe system. A recent personal analysis of the rust deposited by this water discloses an absence of calcium carbonate, thereby indicating its value in the formation of the dense, compact coating. It is obvious, therefore, that deposition of rust in alkaline waters is an indirect method of protection, only effective when constantly used. It cannot be an intermittent procedure.

Many plants control the application of lime by hourly pH color tests. The development in 1923 of the tungsten electrode, pH 6.0 to 12.0, made possible the use of recording potentiometers for the regulation of the lime application. The correct treatment is easily determined by the von Heyer (3) marble test. Daily determinations should be made and when sufficient data have been secured, a curve similar to that developed by Baylis should be plotted for each plant.

LIME TREATMENT

With the application of corrective treatment, even when using the most accurate control devices and with well trained personnel, occasional slight precipitation of insoluble calcium carbonate is to be expected. It is impossible to prevent minute concentrations of hydroxyl ions above the carbonate saturation point, even for short periods, with a resultant precipitation. This is to be expected with either lime or caustic soda for both compounds convert the calcium bicarbonate into the insoluble carbonate. These materials should

be applied in such a manner that sedimentation will occur in a clear well to prevent consumer complaint from sediment in the lines.

BENEFITS OF TREATMENT

Corrosion of mains causes the formation of incrustations and tubercles which greatly increase friction losses and reduce their carrying capacities. In the case of small mains, they may become almost useless unless they are occasionally cleaned. If mains are cleaned and the water not corrected, corrosion activity is increased due to the exposure of fresh iron surfaces, and it will be only a few years until they again require cleaning. The many buildings connected to water supplies are equipped with very expensive piping systems of wrought iron, steel, brass and galvanized iron, which are readily attacked by corrosive water. While it is not possible to determine accurately the cost due to corrosion in such systems, where no provision is made for prevention, it unquestionably is great. Should the "soft water" cities omit corrective treatment, the familiar "red water trouble" would cause innumerable complaints from householders regarding the staining of clothes, bathroom fixtures, etc. In addition to the direct replacement cost of pipe due to corrosion, a host of indirect costs would accrue, occasioned by damage to plaster, furniture and other goods. While it is not possible to place a material value upon an intangible asset, freedom from complaints and ill feeling is worth much to any community or company. If this may be secured, it would in itself justify a large monetary outlay. It is very unwise to attempt an evaluation of the increased years of service given to pipe lines by corrective treatment. There are many variables to be considered, external electrolysis being perhaps the most common. The operating and maintenance costs for the pipe system owned by this Bureau were much less in 1935 than in any given year or period of years prior to 1925, when corrective treatment was not used.

ECONOMIC FACTORS

Corrective treatment with lime increased the total hardness of the Baltimore water about 8 parts per million or 18.2 percent at a cost of 17 cents per million gallons.

As would be expected, laundries, ice manufacturing plants and other establishments soften water with zeolite installations to prevent

soap loss or to produce a uniform product. These installations range between 100,000 and 500,000 gallons per day capacity. About 30 million gallons per year per installation are treated at a cost for this excess hardness of 0.66 cent per 1,000 gallons or $196.76 per year. Considered as a portion of the business overhead, this is a very small item.

Data obtained from the operation of a similar softener at the steam plant connected with the McMillan Filtration Plant at Washington, D. C., (11), gives a cost due to corrective treatment, 12.5 percent of the total, or 0.7 cent per 1,000 gallons or $57.80 per year. Compared to 0.66 cent at Baltimore, it is easily seen that the cost of corrective treatment to industry is very little and more or less uniform when moderately hard waters are utilized.

A study was made in a large manufacturing plant having a yearly steam capacity of 192 million pounds, using 40 percent "make up" water. The softening cost was 14 cents per 1,000 gallons of water used. Their "blow down" cost approximated 14.9 cents per 1,000 gallons. The cost of softening water in the boiler, including return, was 6 cents per 1,000 gallons. Therefore, the increased cost caused by lime treatment was 3.2 cents per 1,000 gallons of "make up" water or $295.47 per year.

To obtain some idea of the soap waste caused by corrective treatment, the softening value of various commercial brands of soap and soap powders was determined. The added hardness caused by lime treatment produced an average soap waste increase of 1.0 ounce per 1,000 gallons for toilet soaps; 1.3 ounces for kitchen soaps and 3.6 ounces for soap powders. The most popular brands of toilet soaps ranged from 0.8 to 1.3 ounces per 1,000 gallons. This work indicated that the cost of soap waste caused by corrective treatment averaged 0.04 cent per gallon based upon the standard retail price, *assuming all of the water was completely softened*, which does not occur in actual use as more is used for rinsing than is used with soap. Hudson and Buswell (10) give the per capita soap consumption for several cities in which the hardness of the waters varies considerably. These data indicate that every part per million of hardness causes a per capita increased soap cost of about 1 cent per year. It is obvious, therefore, that these cost data assumptions should be taken only in general terms, but they do show that the family expense for corrective treatment in terms of soap waste is not great.

USE OF SODIUM COMPOUNDS FOR ADSORPTION OF CARBON DIOXIDE

Neutralization of carbon dioxide is practical with caustic soda for the maintenance of a calcium carbonate film in the pipe system. There will be no increase, under some conditions, a slight decrease, in hardness by this treatment. Precipitation of a film by sodium compounds is usually uneconomical. Protection of the previously formed film in this water, operating at a pH value of 7.9, required 5.5 parts per million of lime, 8.9 parts of caustic soda and 22.2 parts of soda ash. Converting these data into money values it is evident that the purification cost would be increased $1.84 per million gallons for caustic soda and $2.32 for soda ash as compared to 17 cents for equivalent lime treatment.

ECONOMIC PHASE

In a recent discussion of lime corrective treatment, Powell (12) has shown that financial consideration is an important item, especially where over treatment has occurred. He states:

"The success of anti-corrosion treatment by lime will depend largely on the intelligence of the operators in the proper adjustments to meet local coöperating conditions. Fundamentally, the theory of protective coatings to inhibit corrosion is sound, and assured success will be forthcoming if the rate of scale deposition can be adequately controlled. The difficulty that was experienced in the earlier periods of treatment was due largely to a lack of adequate control procedure, and there are many instances where inadequate treatment has resulted in costly operation. . . . .

"In the final analysis, the matter reverts to the preferential rights of the domestic or industrial consumer. . . . . Careful analysis of these conditions in many cases will reveal the fact that no attempt has been made to synchronize the divergent water specification for the two classes of consumers. The problem is difficult but not beyond equitable adjustment."

It is extremely difficult to obtain accurate evaluation of corrective treatment costs as applied to steam generation in industrial life, or of soap consumption in the households of a city or town. The total industrial horsepower used by steam generation is not obtainable for Baltimore or any other city with accuracy. It is impracticable, therefore, to compare steam generating costs in one plant with any other plant, since varying amounts are used in processes, lost in lines, whether the use of heat exchangers is practiced or not, varying "make up" proportions and other factors. *Therefore, it is impossible to draw economic conclusions predicated upon any given plant as characteristic conditions for a community.*

An accurate determination of the water actually softened by soap in a number of households, with carefuly measured quantities over a *long* period of time, with a regulated washing and bathing procedure, would make possible the evaluation of soap waste caused by lime treatment. This would give a fair comparison of cost for estimation of the value to the householder of caustic soda treatment. The indefinite data obtained indicate that the expense of providing sodium compounds for this purpose, about equals the excess soap cost due to lime treatment. It does not appear justifiable under these conditions to increase plant operating costs excessively to permit corrective treatment with sodium compounds, thereby taxing a community for the benefit of its industries, particularly as the added softening burden in relation to plant overhead and cost of process operation is very slight. This is usually reflected in the consumer price, which is a fair proposition, as the person directly benefiting pays the bill. It is believed, therefore, that corrective treatment with lime produces a water of the most value to the greatest number of people.

The interest and coöperation of Mr. Leon Small, Water Engineer and of Mr. James W. Armstrong, Filtration Engineer are much appreciated.

(*Presented before the Southeastern Section meeting, April 9, 1936, and the Four States Section Meeting, April 23, 1936.*)

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DETECTION OF ENDEMIC FLUOROSIS[1]

The remarkable development of knowledge concerning the rôle of fluorine in causing mottled enamel has been previously discussed in these columns.[2] Definite evidence now exists associating the presence of fluorine in drinking water with the endemic hypoplasia of the permanent teeth known as mottled enamel. It is important therefore to determine what constitutes a non-injurious amount of fluoride in a domestic water supply. Any attempts to arrest the further development of this disease are obviously based on definite information concerning the permissible maximum or minimum threshold values for the fluorine content of the water regularly consumed. For public health purposes it is important to establish an arbitrary minimal threshold of fluoride concentration in domestic water supplies so that data obtained in various localities may be related to this norm. The minimal threshold of fluoride concentration has been defined by the United States Public Health Service laboratories as the highest concentration of fluoride incapable of producing a definite degree of mottled enamel in as much as 10 percent of the group examined.[3] The group studied should consist of at least twenty-five children and is restricted, in general, to children 9 years of age or older who, since birth, have continuously used the water under investigation for both drinking and cooking. A community is given a "negative" mottled enamel index when less than 10 percent of the children show "very mild" or more severe types of mottled enamel. With these useful criteria, studies have already been made of endemic fluorosis in eleven cities, six where mottled enamel was known to be endemic and five in which comparable conditions existed but without evidence of the typical dental defects in the population and which served as "controls." Owing to the fluctuating content of fluoride in certain municipal water supplies, caution should be exercised in correlating

[1] Reprinted from Current Comment, Jour. Amer. Medical Assoc., 106: 8, February 22, 1936.

[2] Mottled Enamel, editorial, J. A. M. A., 100: 189, January 21, 1933. The Oakley Experiment on Mottled Enamel, ibid., 101: 214, July 15, 1933.

[3] Dean, H. T., and Elvove, Elias: Pub. Health Rep., 50: 1719, December 6, 1935.

clinical observations with a single chemical determination of fluoride in the water. Furthermore, care must be taken in obtaining the full details of the case histories, as continuous residence in the suspected regions is of great importance in eliciting the abnormalities in the dental structures. On the basis of the foregoing combination of criteria, two municipalities in Illinois with a mean annual fluoride content of 1.7 and 1.8 parts per million in the water, and one city in Colorado with 2.5 parts per million were given a mottled enamel index of "slight," whereas one city in Colorado with 0.6 part per million was listed as "negative." The interesting results and relationships derived from these studies and the application of this method of approach to other regions of this country will undoubtedly provide valuable information regarding endemic fluorosis and indicate the localities in which it is necessary to remove toxic quantities of fluorides from the drinking water.

SOCIETY AFFAIRS

RESOLUTION PASSED BY THE BOARD OF DIRECTORS (JANUARY, 1936 MEETING)

It is the judgment of the Board of Directors of the American Water Works Association, if and when legislation is introduced in the Congress of the United States to place the control of the pollution of water under the Federal Government, that the committee on National Water Policy be authorized to appear before the appropriate Congressional Committee on this subject to advise it of the policy of the American Water Works Association to the effect that, for the present, no further extension of Federal control over streams is desirable, that the Federal Government should restrict its activities in this field to the functions of fact-finding on, and coördination and stimulation of, state and inter-state programs, and that the initiation, administration and financing of projects should be reserved for state and inter-state action.

THE KENTUCKY-TENNESSEE SECTION

The Eleventh Annual Meeting of the Kentucky-Tennessee Section of the American Water Works Association was called to order at 10:30 a.m., March 23, 1936 at the Lafayette Hotel, Lexington, Kentucky, by Chairman L. S. Vance. An address of welcome was given by Mrs. Florence Shelby Cantrill, City Commissioner which was responded to by L. S. Vance. Mr. B. C. Little, Secretary, American Water Works Association brought greetings and news from the Association's office. A report of the Secretary and Treasury of the section was read and approved. Mr. John J. Quinn, the member on the Board of Directors, A. W. W. A. gave a report on the meeting of the Board in New York in January, 1936. After appointment of committees the section adjourned until 1:30 p.m.

A paper entitled "Relation of the Health Department to the Water Works Profession" was read by R. R. Harris, Assistant Engineer, State Department of Health, Louisville, Kentucky. This paper was discussed by Roy Morton, Linn Enslow and F. C. Dugan. Mr. J. S. Watkins, Consulting Engineer, Lexington, Kentucky read a paper on

the "Construction of Small Water Works Systems" which was discussed by H. K. Bell and Linn Enslow. Mr. T. M. Ragsdale, Layne Central Company, Memphis, Tennessee gave a paper on "Well Water Systems in Tennessee and Kentucky." This was discussed by C. M. McCord, H. K. Bell, W. H. Lovejoy, Linn Enslow and F. W. Kittrell. The meeting adjourned at 4:30 p.m.

The Lexington Water Works Company entertained the Association with a dinner at 6:30 p.m. at the Phoenix Hotel.

Tuesday Session

A paper on "Effect of P.W.A. on the Improvement in Water Works" was given by Roy J. Morton, Chief Engineer, State Department of Health, Nashville, Tennessee. Discussion was opened by George Sager, Acting State Director, P.W.A. Louisville, Kentucky.

"Uniform Accounting for Water Utilities" was given by Harry Boggs of Indianapolis, Indiana. Discussion was opened by W. M. Coons of the Lexington Water Works Company.

Mr. C. P. Hoover, Consulting Engineer, Columbus, Ohio gave a paper on "Water Supplies and their Improvement by Softening." A general discussion which was opened by M. E. Flentje, Community Water Service, Greensboro, Pennsylvania, took place.

In the afternoon session "Advancement in Water Works" was the subject of a paper given by L. R. Howson, Consulting Engineer, Chicago, Illinois. The discussion was opened by A. P. Learned, Consulting Engineer, Kansas City, Missouri.

"Aeration, Odor and Carbon Dioxide Removal" was given by M. E. Flentje, Community Water Service, Greensboro, Pennsylvania. A general discussion took place.

"Meters, Maintenance and Installation" was the subject of a paper given by Clem Gallagher, Louisville Water Company, Louisville, Kentucky. A discussion was opened by C. M. McCord, Memphis, Water Company, Memphis, Tennessee.

"Hazards of Cross Connections and their Elimination" was given by A. H. Fletcher, City Health Department, Memphis, Tennessee. Discussion was opened by C. M. McCord. F. C. Dugan presented a motion picture and lantern slides, which were prepared by the Chicago Department of Health on, "Cross Connections in Plumbing and their Dangers to Public Health."

The annual dinner was held at 6:30 p.m. at the Lafayette Hotel. After the dinner a floor show was given. The nominating committee

reported that they nominated Mr. Roy J. Morton, Nashville, Tennessee for chairman, Mr. E. E. Jacobson, Lexington, Kentucky for vice-chairman, Mr. Hall Arnold, Madisonville, Kentucky, Trustee for Kentucky and Mr. C. O. McCord, Memphis, Tennessee, Trustee for Tennessee. These nominated were declared elected.

Mr. E. E. Jacobson then presented, on behalf of the section, a silver cocktail set to F. C. Dugan who had resigned as the Secretary-Treasurer after 11 years of service.

Wednesday Session

The meeting was called to order at 10:00 a.m. March 25 by Roy Morton. A paper on "Improvement in Coagulation" was read by W. J. Eldridge, Old Hickory, Tennessee. A discussion was opened by W. H. Lovejoy, Louisville Water Company, Louisville, Kentucky.

The chairman announced that H. D. Schmidt, State Department of Health, Nashville, Tennessee, had been elected by the Executive Committee to serve as Secretary-Treasurer.

A round table discussion, presided over by A. F. Porzelius, was then held. A motion picture film prepared by Mr. John B. Hawley, Fort Worth, Texas on "Alagae" was shown. W. G. Stromquist, Tennessee Valley Authority, Knoxville, Tennessee opened a discussion of "Malaria Control." Fred Stuart, New York City and Jerry Kavanaugh, Knoxville, Tennessee gave an interesting discussion on the "advancement in Use of Handling Carbon, Ammonia and Chlorine." "Making Friends with the Customers" was the topic of discussion by A. F. Porzelius, Chattanooga, Tennessee. "Problems of the Small Plant Operator" was opened by W. H. Johnson, Harrodsburgh, Kentucky. A discussion on the "Method and Value of Improving Appearance of Water Works Property" was presented by Hall Arnold, Madisonville, Kentucky. H. C. Bristol, Alcoa, Tennessee started a discussion on "Increasing Sales to Present Customer."

The convention was closed at 12:30 p.m., although many took advantage to see the points of interest in the "Blue Grass."

LIST OF SECTION PAPERS

Montana Section

Butte, Mont., April 17–18, 1936

Round Table Discussion.....Led by J. R. Cortese
Licensing of Water Works Personnel.....F. G. Bayerd
A Pension System for Municipal Water Department Employees
A. L. Hewett
Emergencies Due to Severe Winter Conditions.....F. E. Brandis
Soil Temperature Studies.....Prof. Erie Therkelsen
The Freezing and Thawing of Water Services and Hydrants
H. M. Johnson
Equitable Rates on a Flat Rate Basis.....Roy N. Arnold
Complications Arising from Delinquent Accounts.....J. R. Cortese
One Year's Operating Experiences with the Glendive Municipal Water Softening Plant.....C. W. Eyer
The Effect of Wild Animals Upon the Coli Content of Waters
H. B. Foote
Railroad Water Supply Problems in Montana.....E. M. Grime
Early History of the Virginia City (Montana) Water Supply System
Elmer Bickford
The Proper and Safe Handling of Chlorine and Ammonia....Brian L. Shera
Conservation and Public Works.....J. S. James
The Earthquakes of 1935 and the Helena, Montana, City Water System
Joe E. Lupien
Earthquake Resisting Structures.....V. H. Walsh
Informal Address.....Eugene Carroll

Pacific Northwest Section

Aberdeen, Wash., May 14–16, 1936

Round Table Discussion.....Leader, H. D. Fowler

1. Joint Material for Cast Iron Mains
2. Gate Valve and Hydrant Inspection
3. Protective Paint for Standpipes
4. Collections, and Delinquent Accounts
5. Billing and Records, Tap Records, etc.
6. Meter Repairs, Inspections, and Records, Service Pipe Connections and Taps
7. Location of Water Mains and Service Connections
8. Cross-Connections in Water System

P. W. A. Projects in Washington.....E. R. Hoffman
Aberdeen Water System.....S. C. Watkins
Reconstruction and Extension of the Green River Gravity Water System, Tacoma, Wash.....W. A. Kunigk
Watershed Protection and Control.....G. M. Irwin
Cost of Fire Protection in a Water System.....Sydney J. Benedict
Business Principles of Sound Municipal Utilities Management
J. W. McArthur
Water Rates in the Pacific Northwest.....G. B. Schunke

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, **12**: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

Solubility of Calcium Salts in Boiler Water. FREDERICK G. STRAUB. Trans. Am. Soc. Mech. Engrs. (Fuels and Steam Power), **54**: 221–30, 1932; cf. C. A., **27**: 1426. From Chem. Abst., **28**: 3154, May 20, 1934. Solubility graphs for:—calcium sulfate; calcium carbonate; mixtures of calcium sulfate and carbonate; of calcium sulfate and sodium carbonate; of calcium and sodium sulfates; of calcium sulfate and sodium hydroxide; of calcium carbonate and sodium sulfate; of calcium and sodium carbonates and calcium sulfate; of calcium carbonate and calcium and sodium sulfates; and of calcium carbonate, calcium sulfate, and sodium hydroxide are given for temperatures 360°, 405°, 470°, 540°, and 600°F. Solubility of calcium carbonate decreases as temperatures increases. At temperatures studied, calcium carbonate is practically insoluble in presence of sodium carbonate or hydroxide. Solubility of calcium sulfate is not directly proportional to sulfate in solution and calcium sulfate cannot exist as solid phase in equilibrium with solutions of sodium carbonate even at pressures up to 1500 pounds. Ratio of carbonate to sulfate necessary to prevent deposition of calcium sulfate is not nearly so high as was supposed.—*R. E. Thompson.*

A New Boiler-Water Treatment for the United States Navy. THORVALD A. SOLBERG and ROBERT C. ADAMS, Jr. Combustion, **5**: 6, 24–9, 1933. From Chem. Abst. **28**: 3154, May 20, 1934. After extensive studies of feed water and scales from 20 ships located at widely separated stations and comparative trials of colloidal, coating, electrolytic, and chemical methods of feed water treatment at United States Naval Experiment Station, a new Navy formula was evolved:—anhydrous disodium phosphate 47, soda ash 44, and corn starch 9. New compound is discussed by R. E. HALL, C. W. RICE, A. HOLMES, and A. C. PURDY in succeeding issue, No. 7.—*R. E. Thompson.*

Water Supply and Its Relation to Public Health in Chicago. T. SCHMID, Jr. Trans. Illinois State Acad. Sci., **25**: 159–60, 1933. From Chem. Abst., **28**: 3813, June 20, 1934. Historical.—*R. E. Thompson.*

Determination of Potassium in Mineral Waters and in Other Solutions. V. CRASU and V. MANOLE. Bul. soc. chim. România, **15**: 129–36, 1933. From Chem. Abst., **28**: 3335, June 10, 1934. Method depends on preliminary pre-

cipitation of $K_2NaCo(NO_2)_6$ and final precipitation of K_2PtCl_6. (*Reagent* is prepared by dissolving 100 grams cobalt nitrate crystals and 650 grams sodium nitrite in 800 cc. water, adding 4 cc. glacial acetic acid, stirring, and, after standing 24 hours, filtering and washing precipitate until volume of filtrate is 1 liter.) Concentrate solution as much as possible, neutralize with acetic or nitric acid or with sodium hydroxide, add 15 cc. reagent for each 100 cc. solution and sufficient acetic acid to make solution contain 5 percent by volume, and allow to stand 4 hours. Filter and make sure filtrate gives no further reaction with more reagent. Transfer precipitate to filter with some of filtrate. Press precipitate as dry as possible and ignite together with filter. Without attempting to get ash entirely free from carbon, take up with dilute hydrochloric acid, filter, and wash with water. Evaporate to dryness, take up residue in 1 or 2 cc. water, add chloroplatinic acid and enough ethyl alcohol to make mixture contain 80 percent alcohol by volume. Filter, wash precipitate with alcohol, dissolve in hot water, and precipitate platinum by boiling 10 minutes with 3 to 5 cc. 10 percent sodium formate. Filter, calcine, and weigh platinum. Results obtained in analysis of mixtures containing from 10 to 50 milligrams potassium in presence of much larger amounts of sodium chloride, sodium sulfate, calcium chloride, magnesium chloride, sodium silicate, disodium phosphate, ferric chloride, etc., were all within 2.5 percent of truth.—*R. E. Thompson.*

Determination of the Water Content of Liquid Sulfur Dioxide. Paul Woog, René Sigwalt, and Jean de Saint-Mars. Bull. soc. chim., **53**: 1522–4, 1933. From Chem. Abst., **28**: 3336, June 10, 1934. Water content of liquid sulfur dioxide is of considerable importance, particularly with respect to corrosion. By cooling sample first in ice and salt and then in mixtures of acetone and solid carbon dioxide and noting temperature at which ice crystals first appear, it is possible to determine water content with satisfactory accuracy. Apparatus for carrying out test is described.—*R. E. Thompson.*

Methods for Analyzing Solutions of Hypochlorous Acid. M. Lemarchands and D. Saunier. Bull. soc. chim., **53**: 1414–18, 1933. From Chem. Abst. **28**: 3337, June 10, 1934. Iodometric methods were studied. Good results were obtained by adding sodium arsenite solution and titrating back with potassium iodate solution, provided that sufficient sodium bicarbonate was used. Alkalimetric method of Lunge also proved satisfactory. If solution is treated with neutral potassium iodide, hypochlorous acid oxidizes iodide to iodine or iodate, and free chlorine also liberates iodine; iodine can be titrated with thiosulfate. Then, on acidification, iodate reacts with potassium iodide and liberates more iodine. Mixture of chlorine and hypochlorous acid can, therefore, be analyzed in 2 ways: by combined thiosulfate and alkalimetric titration after treatment with potassium iodide or by adding potassium iodide and titrating twice with thiosulfate.—*R. E. Thompson.*

Corrosion and Residual Current. L. W. Haase. Korrosion u. Metallschutz, **8**: 281–8, 1932. From Chem. Abst., **28**: 3367, June 10, 1934. Corrosion current measured in presence of oxygen consists of oxygen-depolarization cur-

rent and current depending on material and temperature. Statement, that at pH 5 to 9 iron dissolves only in presence of oxygen, holds at room temperature; but not at 50–90°. Theoretical quantity of sulfite does not protect against corrosion; 5 to 10 percent excess is necessary.—*R. E. Thompson.*

Economics of Cathodic Pipe Protection. W. R. SCHNEIDER. Western Gas, 10: 1, 12–13 and 39, 1934; cf. C. A., 27: 3318. From Chem. Abst. 28: 3369, June 10, 1934. Discussion of major points affecting condition of pipe line, its probable life, and type of additional protection to apply in case of excessive depreciation. Also in Gas Age-Record, 73: 11–13, 1934.—*R. E. Thompson.*

Corrosion Phenomena in High-Pressure Boilers. K. HOFER. Stahl u. Eisen, 53: 925–9, 1933. From Chem. Abst., 28: 3367, June 10, 1934. Three general types of corrosion were noted:—(*a*) flat depressions, caused by pH of water, (*b*) local pits, due to high oxygen concentration in water, and (*c*) scaling due to direct action of steam on steel. These effects may be accentuated by mechanical action in boiler, by presence of stresses in steel and irregularities in its structure, by constructional faults, especially those causing disturbances in water flow, by incorrect preparation of feed water, and by formation of boiler scale and foaming of boiler water. Examples of action of these faults are shown and discussed. To prevent their occurrence feed water must be carefully purified and degassed; it must have minimum alkalinity and contain certain amount of protective salt, depending on nature of water, performance of boiler, pressure, and working conditions. In building boiler, cold-work must be studiously avoided to prevent internal stresses, and working surface should be of such nature as to prevent adherence of gas or steam bubbles.—*R. E. Thompson.*

Determination of the Loss of Weight in Corrosion Tests. ALBERT PORTEVIN. Rev. mét., 30: 275–9, 1933. From Chem. Abst., 28: 3367, June 10, 1934. Amount of corrosion can be determined by weighing before and after corrosion, by determining amount of corrosion products, or by determining weight of specimen with products of corrosion. When latter are gaseous or soluble, problem is simplified. With solid corrosion products, they can be dissolved by reagent not affecting metal, latter can be removed, deposit can be converted into easily removable substance, or corrosion layer can be removed by gas evolution. For rust removal, solution containing 30 cc. hydrochloric acid (22 Bé.), 1 cc. 40 percent formaldehyde, 0.2 gram arsenious oxide, 0.5 gram stannous chloride, with water to make up 100 cc. gives good results. About 800 cc. should be used for every 100 square centimeter of specimen and solution discarded before it becomes yellowish. Cold solution, continuous stirring, and occasional brushing are recommended.—*R. E. Thompson.*

The Principle of the Corrosion of Metals. J. GLAYMANN. Science et ind., 18: 48–50, 1934. From Chem. Abst., 28: 3368, June 10, 1934. Author shows that corrosion, whatever form it takes, follows electrolytic theory of metals. From some well-known experiments on attack of metals by acids, which constitutes primary form of corrosion, he deduces following law which can ex-

plain numerous cases of corrosion, and more particularly certain cases of corrosion of boilers and water pipes: "The necessary and sufficient condition to permit corrosion of substance is that it constitute one or other of the electrodes (most frequently the anode) of a normal electrolytic cell."—*R. E. Thompson.*

Effects of Chlorinated Water on Land Plants, Aquatic Plants and Goldfish. P. W. ZIMMERMAN and ROBERT O. BERG. Contrib. Boyce Thompson Inst., **6**: 39–49, 1934. From Chem. Abst., **28**: 3443, June 10, 1934. Concentration of 50 p.p.m., or less, of chlorine in water was not injurious to plants tested; 100 and 150 p.p.m. injured or retarded some plants and did not affect others; 200 and 300 p.p.m. injured tops of plants and did not injure roots; 500 and 1000 p.p.m. retarded growth of seedlings, and killed tops and roots of plants. Watering and syringing together was more injurious than watering. Plants grown in loam and sand mixture were more resistant to chlorinated water than those grown in sand. Roots from tomato cuttings in chlorinated water were retarded in growth directly as chlorine concentration increased from 10 p.p.m., but were not affected by 5 p.p.m. Cut flowers were not affected by concentrations of up to 10 p.p.m. Goldfish were killed by chlorine solutions of 1.5, 2.0, and 3.0 p.p.m. when water was changed daily, or, in running water, by chlorine solutions of 1.0 and 1.5 p.p.m. Aquatic plants were affected by 3 p.p.m. or more of chlorine.—*R. E. Thompson.*

Improving Unsuitable Water for Use in Vegetable Tanning and Preparing Tan Liquors. LEOPOLD POLLAK. Gerber, **60**: 17–19, 1934. From Chem. Abst., **28**: 3613, June 10, 1934. Brief discussion of advantages and methods of treating water for tannery use.—*R. E. Thompson.*

Approximate Estimation of Sulfate in Drinking Water. L. W. WINKLER. Pharm. Zentralhalle, **74**: 319–20, 1933. From Chem. Abst., **28**: 3502, June 10, 1934. Into 50-cc. Erlenmeyer flask introduce 10 cc. perfectly clear sample, add 2.5 cc. 10 percent hydrochloric acid and follow with 5 cc. 10 percent barium chloride, mix and observe exactly with stop-watch interval in seconds until first appearance of turbidity. Table is given showing SO_3 concentrations corresponding to intervals between 5 and 15 seconds. If turbidity appears before 5, or later than 15 seconds, acidify sample with 5 or with 1 cc. of hydrochloric acid, note interval as before, and read SO_3 concentration from appropriate column in table.—*R. E. Thompson.*

New Colorimetric Method for Determining Lead. S. FEINBERG. Z. anal. Chem., **96**: 415–8, 1934. From Chem. Abst., **28**: 3685, June 20, 1934. Method consists of converting lead to lead molybdate, dissolving precipitate, and determining molybdenum content colorimetrically by reaction with potassium sulfocyanide and stannous chloride in presence of hydrochloric acid. Method is suitable for determining from 1 to 2 milligrams lead.—*R. E. Thompson.*

Factors Limiting the Sensitivity and Accuracy of the Test for Dissolved Oxygen. SALVATORE ALFANO. Combustion, **5**: 9, 16–20, 1934. From Chem. Abst., **28**: 3687, June 20, 1934. WINKLER method of determining dissolved

oxygen may fail to indicate oxygen even when enough is present to cause corrosion. Error may be due to incomplete oxidation of manganese, to incomplete liberation of iodine, or to working at temperatures above 5°.—*R. E. Thompson.*

Progress in Mitigating Soil Corrosion. GORDON N. SCOTT. Am. Petroleum Inst., Proc., 14th Ann. Meeting, Section IV, 130–42, 1933. From C. A. 28:3704, June 20, 1934. Review, with numerous references.—*R. E. Thompson.*

Effect of Electrical Drainage on Bituminous Pipe Coatings. A. B. ALLYNE. Gas Age-Record, 73: 347–50, 1934. From Chem. Abst., 28: 3703, June 20, 1934. While rate of corrosion of steel pipe may be greatly reduced if pipe is held negative to soil by electrical drainage, little is known concerning effect of this negative potential on pipe coatings. Laboratory tests showed that both asphalt and coal-tar coatings lost their bond and blistered when subjected to potential of 4.3 volts below soil potential while at 0 to 0.3 volt no failure occurred. Electrical resistance of these coatings decreases when pipe is buried in soil and is independent of cathodic protection.—*R. E. Thompson.*

Corrosion of Asphalt-Coated Iron Pipes. C. M. WICHERS. Gas- u. Wasserfach, 77: 131–2, 1934. From Chem. Abst., 28: 3703, June 20, 1934. Asphalt coatings, even when applied hot at factory, tend to have great number of pinholes and are also easily injured in handling and laying. Experience with coal-tar coatings has indicated that they rupture easily and that pipes so coated are corroded in corrosive soils. Some soils, normally termed corrosive, may actually pack so closely about pipe as to protect it. Attempts to correlate irregular corrosion of cast-iron pipes with differences in composition of metal failed completely.—*R. E. Thompson.*

Corrosion Fatigue and Protective Coatings. F. N. SPELLER and I. B. MCCORKLE. Am. Petroleum Inst., Proc., 14th Ann. Meeting, Sect. IV, 24–8, 1933; cf. C. A., 28: 449. From Chem. Abst., 28: 3703, June 20, 1934. Preliminary results of static corrosion and corrosion-fatigue tests are given, in which specimens were protected by 8 different types of organic coatings. Protective power of coatings is liable to be greatly diminished under cyclic strain. While paint coatings seem to afford some protection against corrosion fatigue, necessity of correlating service tests is stressed.—*R. E. Thompson.*

Colorimetric Determination of Fluorine. E. PEYROT. Ann. chim. applicata, 24: 74–8, 1934. From Chem. Abst., 28: 3687, June 20, 1934. Methods of STEIGER (C. A., 2: 1104) and TREADWELL and KOCH (Z. anal. Chem., 43: 469, 1904) have been combined and improved. Treat material, ashed or pulverized, with concentrated sulfuric acid in PENFIELD apparatus. Collect evolved gases in 0.5 normal sodium hydroxide (instead of potassium chloride): $SiF_4 + 4NaOH \rightarrow SiO_2 + 4\ NaF + 2H_2O$. This reaction does not occur with potassium hydroxide. Carbon dioxide, sulfur dioxide and trioxide, and hydrochloric acid do not interfere. Filter solution and make up to volume. Make solution of titanium sulfate by dissolving 0.6 gram titanium oxide in

60 to 70 cc. sulfuric acid and boiling 2 or 3 hours. Cool, add 500 to 600 cc. water, and heat again until all titanium sulfate is dissolved; dilute to 1 liter. Add enough fluorine solution to contain from 2 to 3 milligrams fluorine to 25 cc. titanium solution with 2 or 3 drops of hydrogen peroxide and dilute to 100 cc. Compare color with blank according to STEIGER. As standard color solution is not stable, dilute solution of potassium dichromate may be used as standard.—*R. E. Thompson.*

Cathodic Protection of Underground Pipe Lines from Soil Corrosion. ROBERT J. KUHN. Am. Petroleum Inst., Proc., 14th Ann. Meeting, Sect. IV, 153–67, 1933. From Chem. Abst. **28**: 3703, June 20, 1934. Detailed discussion of mechanical and electrical problems involved in cathodic pipe line protection with numerous references.—*R. E. Thompson.*

Corrosion Studies in Steam Heating Systems. R. R. SEEBER, F. A. ROHRMAN and G. E. SMEDBURG. Heating, Piping, Air Conditioning, **6**: 124–6, 1934. From Chem. Abst., **28**: 3704, June 20, 1934. Progress to date is reported on investigation of respective relationships of oxygen, carbon dioxide, pH value, and method of operation to corrosiveness of condensate in steam heating systems.—*R. E. Thompson.*

The Cause and Prevention of Calcium Sulfate Scale in Steam Boilers. FREDERICK G. STRAUB. Univ. Ill. Eng. Expt. Sta. Bull. **261**: 75 pp., 1933. From Chem. Abst., **28**: 3817, June 20, 1934. Fundamental facts were sought regarding scale formation and behavior of calcium solutions in general in boilers under wide ranges of pressure where definite ratios of calcium sulfate to sodium carbonate present must be maintained to prevent caustic embrittlement. Elaborate studies of aqueous systems, calcium sulfate, calcium sulfate-sodium sulfate, calcium sulfate-sodium hydroxide, sodium carbonate-sodium sulfate, sodium chloride-sodium carbonate-sodium hydroxide-calcium sulfate, and calcium carbonate, in bombs heated to maximum temperatures of 540°F., led to following conclusions:—(1) Solubility of calcium carbonate falls with rise of temperature; (2) solubility of calcium carbonate in presence of sodium carbonate or hydroxide is zero at temperatures observed; (3) solubility of calcium sulfate is not directly proportional to sulfate in solution; (4) calcium sulfate cannot exist in solid phase in equilibrium with solutions of 30 p.p.m., or more, sodium carbonate, even at pressures up to 1000 pounds; and (5) Old calculated ratios of carbonate to sulfate to prevent calcium sulfate deposition in solid phase are extremely high. Tests made with experimental boiler to determine extent of conversion of sodium carbonate to sodium hydroxide showed:—(1) controlling factor in decomposition of sodium carbonate in boiler water is partial pressure of carbon dioxide in vapor phase, which in turn depends upon amount and availability of potential carbon dioxide in feed water; (2) with increase in carbonate content of feed water, effect of operating pressure decreases; (3) so far as observed in these tests, boiler rating does not affect decomposition; (4) decomposition decreases with increase in total alkalinity of boiler water; (5) reaction apparently takes place in two stages: $Na_2CO_3 + H_2O \rightarrow NaOH + NaHCO_3$ and $NaHCO_3 \rightarrow NaOH +$

CO_2; (6) complete decomposition is never attained; and (7) hydroxide as determined by ordinary analysis is probably low. Experiments on rate of scale formation in which a "scaling boiler" was used, showed that rate of formation of calcium sulfate is almost constant at 150, 250, and 500-pound pressure. At 1000 pounds, rate is one-third that at 150 pounds (heat-transfer rate constant), while at 2000 pounds it drops to one-tenth. It appears also to be independent of amount of calcium sulfate entering boiler and of amount of sludge present. Presence of more than 30 p.p.m. sodium carbonate in boiler prevents scale formation up to 2000-pound pressure, regardless of concentration of sulfate present. Actual tests with plant boilers have confirmed conclusions based upon laboratory experiments.—*R. E. Thompson.*

Silicon in Boiler Water. R. E. SUMMERS and C. S. KEEVIL. Power Plant Eng., **38**: 219–20, 1934. From Chem. Abst., **28**: 3817, June 20, 1934. Silicon compounds are dangerous on account of their cementing properties in formation of boiler scale. Means to promote solubility of silica are recommended. Highly alkaline phosphates are suggested for this purpose.—*R. E. Thompson.*

The Treatment of Water for Locomotive Boilers, and the Phenomenon of Turbulent Boiling. A. MICHELUCCI and G. B. NALINI. Riv. tec. ferrovie ital., **44**: 168–79, 1933. From Chem. Abst., **28**: 3817, June 20, 1934. Treatment with sodium carbonate (HALL'S method; cf. JONES, C. A., **26**: 1049) is very useful with certain waters, but causes precipitation of sludge which, if not removed, will give rise to turbulent boiling.—*R. E. Thompson.*

The Purification of Drinking Waters by Chlorine. H. LEDERER. Rev. prod. chim., **36**: 549–51, 709–12, 1933. From Chem. Abst. **28**: 3815, June 20, 1934. Chlorination may be carried out by (1) adding sufficient chlorine to ensure oxidation of all oxidizable matter, including bacteria; or (2) adding relatively small proportion of total chlorine requirement, sufficient, however, to sterilize the water. As (2) has frequently given unsatisfactory results, it is being used less and less and (1) is regaining favor it had partially lost. Excess chlorine is best destroyed by adding excess hydrogen peroxide, and this excess in turn is best removed by filter containing manganese dioxide.—*R. E. Thompson.*

Effect of Dilution of Sewage on Bacterial Numbers. H. HEUKELEKIAN. Sewage Works J., **5**: 774–87, 1933. From Chem. Abst., **28**: 3819, June 20, 1934. Changes in bacterial population, as measured by total count and NOBLE'S ferrocyanide citrate agar, were studied in samples of screened sewage diluted to various degrees with phosphate buffer solution and incubated at 20°. Initial increase in numbers of total bacteria and of *Es. coli* were observed in first 24 hours. Thereafter, both diminished rapidly, reaching low level in 3 or 4 days. There seemed to be no correlation between initial dissolved oxygen content and bacterial increase and none between bacterial counts and number and types of protozoa. Tests indicated that neither phosphate nor potassium ions were cause of increase. Results accord with BUTTERFIELD and PURDY hypothesis (C. A. 25, 1930) that bacterial population under any given set of

conditions tends to a certain maximum and if reduced below that level, multiplication is induced.—*R. E. Thompson.*

Some Observed Effects of Dilution on the Bacterial Changes in Polluted Water. J. K. HOSKINS and C. T. BUTTERFIELD. Sewage Works J., **5**: 763–73, 1933. From Chem. Abst., **28**: 3821, June 20, 1934. Samples of polluted water from Mill Creek, Cincinnati, and from various stations on Illinois River were stored at 20° and 37° in undiluted condition and at various dilutions. Agar and gelatin plate counts made at various intervals of time showed that consistent increase in bacterial density occurred in successively higher dilutions of samples from same source and that stored samples showed increases in bacterial density as distance from source of pollution increased. Explanation advanced for this apparent increase in bacteria following dilution is that biological balance prevailing in polluted waters under natural conditions is disturbed by dilution and that number of bacteria-destroying protozoa, which keep bacteria below their limiting numbers, is reduced, so that condition favoring temporary uninterrupted multiplication results. Time for multiplication is provided because generation time of bacteria is less than that of protozoa.—*R. E. Thompson.*

Results of Chlorine Treatment of the City Water Supply of Bern. H. GUBELMANN and W. KÜENZI. Schweiz. Ver. Gas-Wasserfach., Monats-Bull., **14**: 33–8, 1934. From Chem. Abst. **28**: 3816, June 20, 1934. Difficulties were experienced with chlorine treatment (0.1 to 0.12 p.p.m.) (Ibid., **10**: 113–24, 145–52, 177–96, 1930) because of phenol content. By addition of potassium permanganate (.034 p.p.m., or less) to mask chlorophenol taste, turbidity was brought about: addition of hydrogen peroxide (.038 p.p.m.) was likewise unsuccessful. Good results were obtained during last 2 years with addition of .053 p.p.m. ammonia followed few seconds later by about double this amount of chlorine. Phenol complaints have been eliminated, although presence of phenol is proved. Bacteriological results have been satisfactory, coli tests being negative. In addition to results previously published (Z. Desinfekt. Gesundh., **1927**, 617) details are given on effect of 0.1 p.p.m. active chlorine on fauna of water reservoirs. Number of species decreased about 30 percent in 4 years. Several chlorine-resistant types remained.—*R. E. Thompson.*

Removal of Phenols from Waste Waters by Means of Compressed Air. H. BACH. Gesundh.-Ing., **57**: 93–4, 1934. From Chem. Abst., **28**: 3822, June 20, 1934. Author questions economic feasibility of process reported by SCHULZE-FORSTER and L. W. HAASE (C. A., **28**: 1437) when cost of compressed air and heat to keep temperature at about 70° are considered. **Reply.** SCHULZE-FORSTER and L. W. HAASE. Ibid., 94. Up to 0.15 percent of phenols can be removed completely at room temperatures. In gas works, compressed air is available at no cost as by-product of vacuum distillation. Industrial wastes treated are often discharged hot enough to require no additional heating.—*R. E. Thompson.*

Rapid Method for Estimating Magnesia in Brewing Liquors, Softened Waters, etc., by Means of Potassium Palmitate Solution and Its Use in Brewery Labora-

tories. F. M. WIENINGER. Wochschr. Brau., 50: 354–5, 1933. From Chem. Abst., 28: 4169, July 10, 1934. Procedure and apparatus described for modification of FROBOESE method (C. A. 9: 1644).—*R. E. Thompson.*

Detection of Aluminum. KH. N. POCHINOK. J. Applied Chem. (U. S. S. R.), 6: 948–50, 1933. From Chem. Abst., 28: 4001, July 10, 1934. In determining small amounts of aluminum by method of ATACK (C. A., 9: 3186), presence of ammonium hydroxide in aqueous solution causes alizarin to turn to red color resembling that due to aluminum. It is better to carry out test in dilute hydrochloric acid solution well buffered with sodium thiosulfate.—*R. E. Thompson.*

Determination of Available Chlorine in Bleach Liquor. G. BRUHNS. Chem.-Ztg., 57: 817, 1933. From Chem. Abst., 28: 4004, July 10, 1934. Sodium thiosulfate solution, 0.1 normal, prepared from pure crystals, with addition of 5 cc. 0.5 normal sodium hydroxide per liter, covered with paraffin oil, and protected from light, is quite stable. Addition of indigo carmine should have no effect on stability. JUSTIN HAUSNER. Ibid.; cf. C. A., 27: 5027. Stability of indigo carmine-thiosulfate-sodium hydroxide solution is doubted. The antimony solution is more satisfactory.—*R. E. Thompson.*

Determination of Small Amounts of Nitrate in Waters Containing Much Organic Matter. F. DIÉNERT and F. VILLEMAINE. Compt. rend., 198: 1611–12, 1934. From Chem. Abst., 28: 4145, July 10, 1934. Difficulty of removing organic matter without affecting nitrate content is overcome by first removing all nitrogen capable of forming ammonia by adding potassium hydroxide to make solution 14 percent, heating for 2 hours at 120°, and then distilling off half the water. Residue is then treated with 2 grams per 100 cc. of Devarda's alloy and distilled slowly, ammonia formed by reduction of nitrate and nitrite being collected in aqueous boric acid. Nitrite is determined as azo derivative in original liquid.—*R. E. Thompson.*

Determination of the Dissolved Oxygen in Waters Containing Various Reducing and Oxidizing Agents. B. A. SKOPINTZEV and YU. S. OVCHINNIKOVA. J. Applied Chem. (U. S. S. R.), 6: 1173–9, 1933. From Chem. Abst., 28: 4143, July 10, 1934. (1) Waters with high organic content (oxidizability of 20–30 milligrams oxygen) can be analyzed by WINKLER method (WINKLER, Ber., 21: 2843, 1888; C. A., 9: 674), but time for dissolving residue and titration should not be prolonged. With high organic content, WINKLER and iodine tests should be carried out simultaneously; RIDEAL-STUART and ALSTERBERG methods (C. A., 20: 3760) are unsuitable. Solution of residue in acid and titration should be carried out not later than 5 minutes after adding WINKLER reagent. (2) Water containing nitrite can be analyzed by WINKLER method provided nitrite content does not exceed 0.1 p.p.m. In presence of large amounts of nitrite, correct results may be obtained if immediately after solution of residue in acid pH of medium is brought up to about 4.0 by introduction of potassium acetate. (3) Waters containing ferric salts can be analyzed

by WINKLER method if they contain not more than 25 p.p.m. iron; but titration must be carried out within 5 minutes after solution of precipitate in acid if iron content is between 10 and 25 p.p.m. Phosphoric acid (85 percent) must be used to dissolve precipitate. (4) Waters containing active chlorine can be analyzed by WINKLER method if content of chlorine does not exceed 0.3 p.p.m.; otherwise chlorine content must be checked separately.—*R. E. Thompson.*

Indicator Methods for the Determination of the Oxygen Content of Water. H. F. Bergman. Wis. State Cranberry Growers' Assoc. Proc., **44**: 40–6, 1930; Expt. Sta. Record, **68**: 621. From Chem. Abst., **28**: 4143, July 10, 1934. Perch and sunfish exhibit difficulty in breathing when oxygen drops to 2 cc. per liter and are, therefore, valuable indicators of oxygen shortage. Colorimetric method in which phenolic compound which absorbs oxygen becomes colored only in alkaline medium such as sodium carbonate was found very simple and effective.—*R. E. Thompson.*

Determination of Traces of Phenols in Surface Water. T. FOLPMERS. Chem. Weekblad, **31**: 330–3, 1934. From Chem. Abst., **28**: 6219, October 10, 1934. Various methods are critically discussed. GIBBS method (C. A., **21**: 1945–6, 3149) with 2,6-dibromoquinone-chloroimine is influenced too much by presence of oxidizing and reducing impurities and is complicated by buffering. HINDEN-SPLITTGERBER method, with *p*-nitraniline reagent, is easier, but gives variable results because of evaporation in alkaline medium, which may liberate phenolic substances from traces of protein matter. Following standardized method was worked out to avoid these difficulties. Use 750-cc. flask with spattering bulb (all glass) attached to vertical (450 mm.) Liebig condenser. To 1 liter water add 1 cc. strong sulfuric acid for sterilization: then neutralize with sodium hydroxide. Add 2 cc. 10 percent tartaric acid to 500 cc.; distil off 200 cc. in 20 minutes and further reduce volume to 100 cc. in 12 minutes, 50 cc. in 8 minutes, and 25 cc. in 4.5 minutes, each time after addition of 1 cc. hydrochloric acid, and use 250-cc. flask for last 2 evaporation stages. To distillate, after cooling to 0°, add 1.5 cc. diazo reagent and, after mixing, 1.5 cc. normal soda solution; compare resultant color with standards after standing 20 minutes in ice water. Standards contain 0 to 3γ phenol per 25 cc. in 0.2-γ steps. Use 25-cc. (15 cm. long) colorimeter tubes well steamed out. Diazo reagent is prepared by dissolving 140 milligrams *p*-nitraniline in 30 cc. normal hydrochloric acid, adding 100 cc. water, cooling to 0°, and adding gradually solution of 75 milligrams sodium nitrite in 10 cc. water; it keeps at 0°–3° for some few weeks. Check tests showed that appreciable amounts of phenol and cresol were lost by evaporation during distillation, so that results should be multiplied by factor 2.5, instead of 2. Significance of protein (tyrosine) as source of phenol is illustrated from table showing parallel changes in albuminoid ammonia content and in phenol content in water before and after treatment at Rotterdam rapid filtration plant.—*R. E. Thompson.*

Glauconite: Its Distribution and Uses. EDWARD S. SIMPSON. Chem. Eng. Mining Rev., **26**: 391–4, 1934. From Chem. Abst., **28**: 6534, October 20, 1934. Glauconite is earthy mineral, approximating to formula KMg(Fe,

$Al)_3Si_2O_{18}\cdot 3H_2O$. It is used for water softening and other industrial purposes. —*R. E. Thompson.*

Rapid and Accurate Determination of Lime and Magnesia in Natural or Purified Water. ROGER DUROUDIER. Ann. fals., 27: 273–7, 1934. From Chem. Abst., 28: 6219, October 10, 1934. Method is based on titration with alcoholic potassium palmitate, prepared as follows:—mix on water bath 500 cc. propyl alcohol (preferable to ethyl alcohol, especially in cold climates), 200 cc. distilled water, 25.6 grams stearic-acid-free palmitic acid, and 0.1 gram phenolphthalein; when solution is complete, carefully add potassium hydroxide (8 grams in 150 cc. propyl alcohol) to light pink coloration, cool, and make up to 1 liter with propyl alcohol. Standardize as follows:—dilute 20 cc. lime water to 100 cc., titrate with 0.1 normal hydrochloric acid in presence of 2–3 drops 0.1 percent methyl orange; add 2 cc. 1 percent alcoholic phenolphthalein and few drops 0.1 normal sodium hydroxide to permanent light pink, and titrate with palmitate solution to permanent pink. *Determination of lime plus magnesia.* Titrate total alkalinity of 100 cc. water with 0.1 normal hydrochloric acid in presence of methyl orange, add slight excess of acid to decided red, remove liberated carbon dioxide by passing current of air through solution, add 2 cc. 1 percent phenolphthalein and sufficient 0.1 normal sodium hydroxide to produce red color; neutralize exactly with 0.1 normal hydrochloric acid, and titrate slowly with palmitate; let N = cc. used. *Determination of magnesia.* Neutralize alkalinity of 100 cc. water with 0.1 normal hydrochloric acid in presence of methyl orange, add 2 cc. of 1:9 acetic acid, boil 10 minutes, add 0.5 gram finely ground sodium oxalate, boil gently for 1 minute, filter, wash, add 2 cc. 1 percent phenolphthalein and slight excess sodium hydroxide, neutralize exactly with 0.1 normal hydrochloric acid, and titrate slowly with palmitate; let n = cc. used. Then milligrams CaO per liter = $0.028\ (N - n)$ and milligrams MgO per liter = $0.020\ n$. Endpoint is sensitive to 0.05 cc. = 1.4 milligrams CaO, or 1 milligram MgO, per liter. Method requires about 30 minutes and results are practically identical with those of usual methods for calcium and magnesium.—*R. E. Thompson.*

Determination of Sulfate in Drinking Waters. OSKAR HACKL. Z. anal. Chem., 98: 1–3, 1934. From Chem. Abst., 28: 6499, October 20, 1934. Removal of silica by evaporation and dehydration is unnecessary.—*R. E. Thompson.*

Sensitivity of the Iodine-Starch Test. I. M. KORENMAN. Mikrochemie, 15: 25–31. 1934. From Chem. Abst., 28: 6385, October 20, 1934. Sensitiveness of test is shown to depend upon dilution, potassium iodide content, concentration of acid or of sodium bicarbonate present, temperature, presence of other salts, illumination, character of starch, and personal peculiarity of observer. In all iodometric work with dilute solutions, therefore, considerable care should be taken in applying blank test.—*R. E. Thompson.*

Copper and Brass for Heating Lines. CARTER S. COLE. Heating and Ventilating, 31: 8, 37–9 and 72, 1934. From Chem. Abst. 28: 6415, October 20, 1934. Suitability of different grades of brass pipe for use with corrosive waters

is discussed. For soldered joints with copper pipe, ordinary 50–50 tin-lead solder is unsatisfactory and leads to creeping; use of 95 percent tin with 5 percent antimony gives good results. The hard solder Sil-Fos melts at about 700° and is satisfactory for copper tubing carrying steam pressure up to 125 pounds. —*R. E. Thompson.*

Iron and Manganese Removal at the Kaposztasmegyer Waterworks at Budapest. D. MOLNAR. Gas- u. Wasserfach, **77**: 494–500, 1934. From Chem. Abst., **28**: 6500, October 20, 1934. Contamination of well water with river water made iron and manganese removal necessary. Water is treated with large dose of chlorine to oxidize iron and manganese, filtered through "worked-in" quartz filter (1.5-millimeter particle size) to remove oxidized compounds, passed through activated carbon filter to remove excess chlorine, and aërated to reduce acidity. Corrosion in carbon filters, due to iron-carbon couples, can be eliminated by coating pipes with hard rubber and filter shell with paint.—*R. E. Thompson.*

The Germicidal Action of Chlorine. C. S. MUDGE and F. R. SMITH. Proc. 19th Ann. Meeting Western Div. Am. Dairy Sci. Assoc., **1933**, 89–97. From Chem. Abst., **28**: 6450, October 20, 1934. Bactericidal effects of alkaline hypochlorites and of dichloramine were studied. It was concluded that these compounds differ very little in germicidal effect, although dichloramine appeared to be more effective in presence of protein material. Degree to which bacteria are "killed" by treatment with chlorine is discussed. It is suggested that some concentrations of chlorine are merely inhibitory or bacteriostatic. In seeming corroboration, it was shown that dilution of chlorine-treated bacterial preparations operated to increase bacterial plate counts instead of reducing them. This is taken to mean that dilution had changed conditions under which bacteria were dormant, or static, rendering them active and able to indicate their presence. In many cases, therefore, authors question whether bacteria are actually destroyed by chlorine, or merely rendered bacteriostatic. In spite of doubt concerning mechanism of action of chlorine on bacteria, no great objection is raised to its use. It is the abuse of chlorine as bactericidal agent to which objection is raised.—*R. E. Thompson.*

The Manganese Removal Plant at the Leipzig Water Works at Canitz. PFEIFFER. Gas- u. Wasserfach, **77**: 479–83, 1934. From Chem. Abst., **28**: 6499, October 20, 1934. Manganese is removed by filtration through layer of about 1 meter sand, covered with layer of about 0.5 meter of previously used sand. Filtration rate must be low until sand has become "worked-in." Carbon dioxide content is reduced from about 40 to about 2.5 p.p.m., to secure satisfactory manganese removal; practically neutral water giving best results. High pH causes lime deposits in filter.—*R. E. Thompson.*

Deterioration of Sodium Hypochlorite Solutions. W. L. DAVIES. Analyst, **59**: 619–20, 1934. From Chem. Abst., **28**: 6652, November 10, 1934. Sodium hypochlorite solutions with 10 percent available chlorine deteriorate to about half strength in 390–420 days. Reaction constant shows that approximately

$\frac{1}{365}$ of available chlorine is lost daily. When solution contains approximately 10 percent chlorine, daily loss is 0.017 percent. In 746 days, available chlorine was observed to drop from 10.74 to 3.4 percent.—*R. E. Thompson.*

Colorimetric Method for the Direct Determination of Sodium. O. M. SMITH and HERBERT BLAIR. Proc. Oklahoma Acad. Sci., **13**: 33–5, 1934. From Chem. Abst., **28**: 6654, November 10, 1934. Method of CALEY and FOULK (C. A., **23**: 4162) was tested in survey of about 140 samples of water, after preliminary work on 48 other samples. Method is accurate to within about 0.35 milligrams sodium.—*R. E. Thompson.*

Method for the Determination of Ammonia in Water and Air. AUGUST KROGH. Biol. Bull., **67**: 126–31, 1934. From Chem. Abst., **28**: 6655, November 10, 1934. Sample of water is treated with 0.25-normal sodium hydroxide to pH between 9 and 11 and distilled under reduced pressure. Evolved ammonia is absorbed in dilute hydrobromic acid, ammonium bromide solution treated with definite volume standard sodium hypobromite solution at pH from 8.5 to 9, and excess hypobromite titrated with 0.0005 normal naphthyl red, which is decolorized as long as any hypobromite remains. Method is suitable for determination of from 0.05 to 2 γ of nitrogen (cf. TEORELL, C. A., **26**: 4552).—*R. E. Thompson.*

Corrosion of Piping. H. A. WARD. Heating, Piping, Air Conditioning, **6**: 391–2, 1934. From Chem. Abst., **28**: 6689, November 10, 1934. Evidence given of intensely corrosive effect resulting from introduction of cold tap water, saturated with air, into hot return lines. Effect is very noticeably greater when latter are full and there is no ready escape for air from solution.—*R. E. Thompson.*

Zinc Coatings for Water Pipe and Tanks. ERICH NAUMANN. Gas- u. Wasserfach, **77**: 528–33, 1934. From Chem. Abst., **28**: 6685, November 10, 1934. Zinc is strongly attacked by many natural waters, especially by soft and acidic waters which form no protective coating. With increasing carbonate hardness, protective coatings are formed in presence of oxygen. On hot-water tanks and pipes, zinc coatings are generally quickly destroyed. Zinc is more strongly attacked by hot than by cold water. Under 50° a gelatinous adherent oxide layer of relatively high resistance is formed, which is converted into non-adherent pulverulent mass offering no protection at about 55°. At 100°, coating becomes enamel-like and again protective. In soil, cold-water pipes are corroded more rapidly than adjacent gas pipes, presumably as result of condensation.—*R. E. Thompson.*

Some Aspects of the Corrosion Problem. ULICK R. EVANS. Proc. Inst. Civil Engrs. (London), **234**: 445–90, 1932. From Chem. Abst., **28**: 6686, November 10, 1934. Experiments prove that in stagnant solutions corrosion may occur at places less accessible to oxygen, because the ferrous oxide formed is oxidized less rapidly and precipitated less closely to metallic surface. Film will be less protective than that formed in better-aërated sections. Also, this

alkaline section will be anodic and therefore corrode more. Aërated region is cathode of cell. It is impossible to regard some factors as invariably "favorable" and others as always dangerous.—*R. E. Thompson.*

The Presence of Fluorine in the Water Supply of Colorado and Its Relation to the Occurrence of Mottled Enamel. C. H. Boissevain. Colorado Medicine, 30: 142–8, 1933; cf. C. A., 28: 2050. From Chem. Abst., 28: 6886, November 10, 1934. Fluorine was found (titanium sulfate method) in 80 of 169 town supplies examined, 25 containing more than 1 p.p.m. and is thought to originate from fluorite-bearing granite. Concentrations in excess of 1 p.p.m. are associated with 90 to 100 percent prevalence of mottled enamel among native-born children. No mottled enamel was found in absence of fluorine.—*R. E. Thompson.*

A Microscopic Method of Distinguishing Dead from Living Bacterial Cells. Georges Knaysi. Jour. Bact., 30: 2, 193–206, 1935. Using author's modification of neutral red vital staining technique, close agreement was found between number of *groups* of unstained cells and plate count, in *E. coli* cultures. Even to youngest and most sensitive E. coli cells, concentration of 0.005 percent of neutral red was found to be harmless.—*Selma Gottlieb.*

Studies in Acid Production by Escherichia coli and Aërobacter aërogenes. A. V. Syrocki and James E. Fuller. Jour. Bact., 30: 2, 211–2, 1935. Using Clark and Lubs medium buffered with 0.3 per cent K_2HPO_4 and tubed with small amounts of iron filings, acid produced by *E. coli* dissolved enough iron to give test with potassium ferricyanide, but *A. aërogenes* did not. With intermediate strains, results agreed as well with Voges-Proskauer and methyl red tests as did either sodium citrate or uric acid test.—*Selma Gottlieb.*

A Quantitative Differential Method for Counting Mixed Cultures of Bacteria. E. H. Anderson and C. A. Stuart. Jour. Bact., 30: 2, 207–9, 1935. Differences in results obtained by standard and flooded plate methods were statistically insignificant. Directions are given for latter procedure.—*Selma. Gottlieb.*

A Study of Acid and Gas Formation by Members of the Colon-aërogenes-intermediate Groups in the Presence of Certain Sugar Alcohols and their Anhydrides. K. Pierre Dozois, Frank Hachtel, C. Jelleff Carr and John C. Krantz, Jr. Jour. Bact., 30: 2, 189–92, 1935. Dulcitol and mannitol were metabolized by many organisms of coli-aërogenes group, but none utilized their anhydrides. Previous work has shown that these anhydrides are not metabolized in animal body, although dulcitol and mannitol are.—*Selma Gottlieb.*

Diesel Engine Cuts Pumping Costs 70 percent at Gainesville, Texas. Anon. Water Works and Sewerage, 82: 8, 268, August, 1935. Cost of pumping water was 3 cents per thousand gallons when gas-fired steam boilers were in use. With change to oil, cost fell to 2 cents, and with further change to electric

pumping, Diesel generated, to 0.6 cent. Surplus net earnings are used for water-works improvements and for expansion of municipal power plant.—*H. E. Hudson, Jr.*

Water Works Finances; Past, Present, and Future. CHARLES H. CAPEN. Water Works and Sewerage, **82**: 8, 269–273, August, 1935. From analysis of New Jersey water-works data, trend toward public ownership seems probable. Graphical and tabular comparisons of finances of municipal and privately owned water utilities for period 1913–1933 are given, with costs itemized. Effects of depression are discussed. Author would favor increase of municipal water rates, so as to provide reasonable surpluses and reduction of private rates to levels corresponding to prevailing conditions.—*H. E. Hudson, Jr.*

Improved Petri Dish Holder. LUTHER BOATMAN and NEILL KERSHAW. Water Works and Sewerage, **82**: 8, 286, August, 1935. Description of stainless steel frame which separates dishes, protecting them, insuring uniform temperature distribution, reducing breakage, and facilitating easy handling. Cost and illustration are given.—*H. E. Hudson, Jr.*

Battery Meters: Their Installation and Performance. C. M. MCCORD. Water Works and Sewerage, **82**: 8, 287, August, 1935. Tests of registration and loss of head through a battery of 3 2-inch disk meters, a 4-inch compound meter, and a 4-inch turbine meter are presented. Data are presented graphically.—*H. E. Hudson, Jr.*

The Cycles That Cause the Present Drought. HALBERT P. GILLETTE. Water Works and Sewerage, **82**: 8, 289–292, August, 1935. Definite cycles of alternate drought and flood are indicated by tree-ring thickness and varves of ancient glacial lakes. These consist of a "grand cycle" 152 years long and minor cycles of various frequencies. Evidence indicates that rainfall will be subnormal for about 40 years.—*H. E. Hudson, Jr.*

Safety Cylinder Handling Carriage. Anon. Water Works and Sewerage, **82**: 8, 293, August, 1935. Illustrated description of carriage for transport of cylinders containing compressed gas, made from old automobile parts.—*H. E. Hudson, Jr.*

A Rapid Volumetric Method for the Determination of Sulfate in Natural Water and Boiler Blowdown Using Potassium Palmitate. P. HAMER. Chemistry and Industry, **54**: 30, 250–253 T, July 26, 1935. Palmitate solution is made by dissolving 25.63 grams palmitic acid in mixture of 250 grams glycerine and 400 cc. 90 percent alcohol, neutralizing to phenolphthalein with alcoholic potash, and diluting to 1 litre with 90 percent alcohol. Reagent is standardized with barium chloride (0.611 grams barium chloride dihydrate per litre), using 100 cc. Total hardness of water is determined on 100-cc. sample which is first tested for temporary hardness with standard acid using methyl orange, then boiled to expel carbon dioxide, neutralized to phenolphthalein, and finally titrated with palmitate. Sulfate is determined in same way, except that 20

cc. of 0.05 N barium chloride are added to hot carbon-dioxide-free solution, boiling is continued for two minutes, and excess barium is determined with palmitate. Blowdown is diluted 1 in 10, 100-cc. sample is taken, and 40 cc. of barium chloride are added. Good agreement with gravimetric determinations is obtained with natural waters and method is also sufficiently good for boiler feed water conditioning, and is unaffected by phosphates up to 8.0 parts of tri-sodium phosphate per 100,000.—*W. G. Carey.*

A Note on Determination of Dissolved Oxygen in De-aërated Water by Winkler's Method. G. W. Howson and R. L. Rees. Chemistry and Industry, **54**: 30, 254 **T**, July 26, 1935. Titration with iodine not being sensitive enough, "dead-stop" end point (Foulk and Bawden, Jour. Amer. Chem. Soc., 1926, **48**: 2045) is adopted. Beaker, fitted with mechanical stirrer, has two platinum electrodes of 1 square centimeter area spaced 0.5 cm. apart; e.m.f. of about 15 millivolts is applied, and galvanometer connected. After liberation of iodine from sample by Winlker's re-agents, 250 cc. are transferred to beaker, stirrer started, and 0.002 N thiosulfate added from pipette until no current passes through galvanometer, showing polarisation of cathode by slight excess of thiosulfate. Freshly made 0.002 N iodine solution is prepared by adding 2 cc. of 0.02 N potassium dichromate to a few drops of concentrated potassium iodide acidified with hydrochloric acid and diluting with water to 20 cc. Excess of thiosulfate is titrated with this iodine from micro burette until permanent galvanometer deflection is obtained. Volume of thiosulfate equal to first volume of thiosulfate is added and again titrated with iodine. Difference between two titrations is equivalent to iodine liberated by Winkler reaction.—*W. G. Carey.*

Determination of Traces of Cyanide in Water. A. E. Childs and W. C. Ball. Analyst, **60**: 710, 294–299, May, 1935. Filtered sample (500 cc.) is acidified with 0.5 gram tartaric acid and distilled. First 50 cc. distillate contains all cyanide, which is determined colorimetrically in aliquot samples by means either of Prussian blue or of thiocyanate test, either of which is specific for cyanide, or by the much more sensitive silver cyanide test or phenolphthalein test, neither of which, however, is specific. Experimental details for all four tests are given.—*W. G. Carey.*

Use of Sodium Pyrophosphates in Combination with Sodium Metaphosphate in the Determination of Lead in Water. P. Krasten. Chem. Weekblad, 32: 391–393, 1935. From Chemistry and Industry, **54**: 34, 752 **B**, August 23, 1935. Pyrophosphate may be used to prevent iron precipitation in very hard water provided sufficient metaphosphate is also added. Lead is determined colorimetrically by adding two drops of sodium sulphide to 80 cc. of hard water (hardness not exceeding 25 mg. calcium) containing 3 cc. of 10 percent metaphosphate, 1 gram of pyrophosphate, and 10 cc. of acetic-acid-ammonium-chloride solution. In alkaline solution, more pyrophosphate should be added and calcium content should not exceed 20 mgm.—*W. G. Carey.*

Excess Lime Water Purification Process. O. Vollmar. Gas- und Wasserfach, **77**: 1934, 773–779. Treatment of bank filtered river Elbe water (spray

aëration and lime water addition to increase oxygen and remove carbon dioxide, filtration to remove manganese, and chlorination) failed to remove brown colour of organic matter. Treatment with alum, ferric chloride, and permanganate was also unsuccessful. Experiments indicated that excess lime would remove color, manganese, and turbidity after one hour's settlement followed by filtration, water also being rendered softer and partially sterilized. Lime is added as milk of lime at rate of 20 kg. per cubic meter (raising pH from 7.0 to 10.5) and charcoal, 2 grams per cubic meter, to remove odor and taste; water is then sprayed over filter bed to remove manganese and calcium carbonate, treated with carbon dioxide to bring pH to 7.8 and then with 0.06 to 0.12 p.p.m. chlorine. Color is reduced from 32 to 6 parts per million (platinum scale), total hardness from 10 to 7.2 (German degrees), manganese being completely removed.—*W. G. Carey.*

Water Softening at Cambridge (England). E. SUCKLING and P. PORTEOUS. Water and Water Engineering, **37**: 452, 442–457, August, 1935. Water is pumped from chalk and has total hardness of 17 degrees (English) is clear, bright, colorless, palatable, of good organic and bacterial purity, and neutral. Softening was undertaken because inherent economic advantages of softer water would add to amenities and prosperity of district. Part 1 of paper deals exhaustively with chemical, biological, and hygienic considerations, such as origin and nature of hardness, effect of softening on health, advantages of soft water for laundry, hot water systems, etc., methods of softening, and relative merits of lime and base exchange processes, properties of zeolites, and salt consumption and waste in base exchange plants. Part 2 discusses financial and engineering considerations, giving comparative costs of lime and zeolite softening; deals with disposal of sludge and of wash water, and describes plant adopted. Six base exchange units contain about 10 tons of Doucil (an artificial zeolite). Each unit can deliver 16,000 gallons (Imperial) per hour of zero hardness water between regenerations (every 10 hours). Slightly over half the supply is softened and is mixed with remainder to maintain resultant hardness of 8 degrees. Units are regenerated by upward wash, first with brine from previous wash, then with new brine, followed by downward wash with soft water. Taking the cost of salt as 33 shillings per ton and interest at 4 percent per annum, estimated cost of softening is 1.269 pence per 1,000 Imperial gallons of water softened from 18 to 8 English degrees.—*W. G. Carey.*

National Water Supplies. E. Thompson. Chemistry and Industry, **54**: 27, 191–196 **T**, July 5, 1935. Presidential address to Society of Chemical Industry. Reviews present position of water supply in Great Britain. Spirit of localism should be abolished and co-operation between authorities should take its place. Extensive rural areas are now supplied by large water undertakings, but rural dweller often wants something for nothing. During drought many voluntary offers to forego compensation water were made and reduction of 18 percent of water used was quite general. There is considerable waste in homes and after frost. Investigation of underground water should be undertaken. During last 25 years, rate of fall in water level in London wells

has increased from 1.5 feet to 4 feet per annum. Investigation is required as to whether soft water provides sufficient lime for health. Details are given of water supplies in various towns in Great Britain and America, the notably higher consumption per head in America being pointed out. Systematic records of rainfall, of river and lake flow, and of underground water levels are necessary in order to deal with anticipated increased consumption. Slow and rapid sand filters have reached high degree of efficiency. Storage, even for single day, has reduced organisms by 40 percent; but encourages plant and animal life. Industrial development, on the other hand, leads to increased river pollution, necessitating widespread chlorination. Disposal of sewage is dealt with and investigation of River Mersey discharges mentioned. There is room for improvement in valuation of waterworks rating, in assessment of compensation water, in basis of water examination and in interpretation of results.—*W. G. Carey.*

Some Studies on Water Purification. A. H. WADDINGTON. Water and Water Engineering, **37**: 443, 28–31, January, 1935, and 444, 57–64, February, 1935. Majority of new sources of water require chemical treatment before filtration, and chemicals commonly used are given. Dry-feed is replacing solution feed and economy and advantage of slow stirring of dosed water over simple mixing is recognized; few waters requiring sedimentation fail to respond to slow stirring for 5 to 25 minutes. Improved coagulation is also obtained by prechlorination, or by split chemical treatment. In filtration, modern tendency is to use coarser filter bed, and for cleansing, combined air agitation and water wash has proved superior to other methods, air agitation aërating filter bed and gelatinous film which forms on sand grains practically throughout bed. Aëration to remove carbon dioxide from water and neutralization to bring pH of hard waters to 7.4 and of soft waters, to 7.8, or higher, are advocated. Chlorination, or ammonia-chlorine, is best known sterilizing agent; ozonization is more costly and has not advantage of residual disinfectant action. For preventing tastes and odors, chloramine, activated carbon, and algal control are advocated. Author then gives examples of correct treatment of five different waters and discusses advantages of municipal softening. Plant control, testing equipment, and chemical control are also discussed.—*W. G. Carey.*

Thermodynamics of Base Exchange Equilibria of Some Different Kinds of Clays. J. KIELLAND. Chemistry and Industry, **54**: 28, 232–234 **T**, July 12, 1935. Outline of thermodynamical method of treating base exchange equilibria, taking into account activity coefficients of zeolite components. Constant log K value has been obtained and enables occurrence of intermediate compounds to be detected. Preliminary values for free energies of nine different zeolites are given.—*W. G. Carey.*

Biological Research in Relation to Water Supply. P. ULLYOTT. Water and Water Engineering, **37**: 453, 489–490, September, 1935. Every reservoir represents in miniature a lake and is subject to same modifying factors, namely:—temperature, light penetration, suspended matter, hydrogen ion concen-

tration, dissolved gases, and dissolved mineral and organic matter. Temperature causes an important yearly cycle of conditions owing to differences in density with differences in temperature. During winter, lake is uniform in temperature throughout and there is therefore no stagnation; but in summer, surface layers are warmed, resulting in differing densities and consequent stagnation. Line dividing upper mass of warmer water from lower mass of cooler water is surprisingly sharp. This is important for plant life which needs light, carbon dioxide, and salts; thus algae cannot grow in the lower stagnant water, while upper mass is continuously depleted of salts by dead algae sinking into lower mass.—*W. G. Carey.*

Method Used at Oklahoma City for Thawing Frozen Pipes. S. KARL BEAN. Southwest Water Works Jour. **17**: 11, 14, 1936. Special generator, driven by internal combustion engine, is preferred.—*O. M. Smith.*

Proper Sanitary Control of a Deep Well Supply. BEN L. GRIMES, Jr. Southwest Water Works Jour. **17**: 11, 21–22, 1936. City of El Paso, Texas, maintains its right to protect its well supply by an ordinance regulating the construction, operation, and abandonment of privately owned wells.—*O. M. Smith.*

Utility Accounting Methods. RAYMOND E. LEE. Southwest Water Works Jour., **17**: 11–13, 23–24, 1936. Comprehensive review of subject of Customers' Accounting, as exemplified in practice of Houston, Texas, Lighting and Power Co. with respect to customers' contracts, meter reading, billing, revenue analysis, customers' records, delinquent accounts, and collections.—*O. M. Smith.*

Brief Discussion on Safeguarding Water Plants. E. H. PEARL and E. A. EHLERS. Southwest Water Works Jour., **17**, 10, 23–24, 1936. Excellent summary of recommendations by Texas State Department of Health, tabulated as to source of supply, treatment, reservoirs, and distribution system.—*O. M. Smith.*

Drinking Water Supplies at Industrial Plants. W. J. SCOTT. Connecticut Health Bulletin, **48**: 12, 271, December, 1934. For past two years, Bureau of Sanitary Engineering has been engaged in its first complete survey of factory drinking water supplies in Connecticut. Of 197 factories using private drinking water supplies, only 5 use surface supplies. Of 200 supplies examined, it was considered that 119, or about 60 percent, were in good, or fairly good, condition. Remaining supplies ranged from fair to poor. It was roughly estimated that 26,500 factory employees were being provided with private drinking water. In this survey 34 cross-connections were disclosed and were ordered severed.—*G. C. Houser.*

The State Health Department. Health Bulletin (N. C. State Board of Health), **50**: 1, 4, January, 1935. Division of Sanitary Engineering renders service on all non-medical phases of sanitary and public health work. There

are at present some 229 public water supplies in North Carolina, catering to municipalities having total estimated population in 1935 of 1,160,000. During past 2 years there has been but one water-borne outbreak of serious nature in the State. In that case untreated sewage found its way into a water supply, with result that there were over 40 cases of typhoid and 3 deaths. During the biennium 1909 to 1911, 3,600 specimens of water were examined in State Laboratory of Hygiene; during the biennium 1932–1934, 11,479.—*G. C. Houser.*

Practical Considerations Involved in the Control of Pollution of Public Waters in New Hampshire. C. D. HOWARD. Health (N. H. State Board of Health), January, 1935. Author believes program of State Planning Board should involve two immediate objectives; first, the removal of all material pollution from lakes and ponds of N. H.; and second, the reclamation of contaminated recreational streams and preservation of purity of those as yet uncontaminated. Author cites two cases which are outstanding in calling for remedial action. One of these concerns Lake Winnisquam, the only grossly polluted lake at this time in N. H. Introduction at coming session of bill relating to this lake seems probable. There is also possibility of legislation concerning Ammonoosuc River.—*G. C. Houser.*

Progress in Typhoid Eradication. Health News (N. Y. State Dept. of Health), **12**: 6, 22, February 11, 1935. In 1929 there were 609 cases and 86 deaths from typhoid fever in New York State exclusive of New York City. In 1934 there were only 338 cases and 41 deaths, the 1934 numbers being lower than those for any previous year on record. The proportion of State's population served by properly treated public water supplies increased from 45 percent in 1922 to 64 percent in 1933. Not a single typhoid epidemic proved to be due to a contaminated municipal water supply has occurred in New York State since 1928.—*G. C. Houser.*

Cross-Connections in Plumbing. Wisconsin State Board of Health Bulletin, **5**: 21, 15, January–March, 1935. Methods of preventing spread of dangerous water-borne diseases that can be communicated through improper plumbing fixtures and installations form subject of a pamphlet published in January by University of Wisconsin and State Board of Health. Several plumbing fixtures now on the market are potentially dangerous to public health and are prohibited from use in Wisconsin. Back-siphonage is greatest health hazard in modern plumbing. In many installations such faults as undersized pipes and improper appliances make back-siphonage possible. In such set-ups it occurs frequently when water is shut off for repairs at a time when stoppages in drainage system exist.—*G. C. Houser.*

Control and Prevention of the Coastal Pollution along the North Jersey Coast. S. A. KOWALCHIK and H. C. GREENFIELD. Public Health News (N. J. Dept. of Health), **19**: 3, 400, March, 1935. Potable Water Act of N. J. prohibits any discharge of polluting material into waters of state upstream from point at which any municipality shall, or may, obtain its public water supply for domestic use. This act tends to eliminate entrance of any pollution above

New Milford into Hackensack River; above Little Falls, into Passaic River; above Rahway, into Rahway River; above junction of Millstone and Raritan Rivers; and above mouth of Laurence Brook. In 1925, State Department of Health adopted the policy that all polluting material discharged into potable watershed shall be subjected to treatment which shall include sedimentation, oxidation, and chlorination. With few exceptions, all polluting matter of any consequence, discharged into aforementioned potable watersheds, is treated accordingly.—*G. C. Houser.*

Water Treatment Plants Increase Rapidly in Ohio. Ohio Health News, **11**: 5, 4, March 1, 1935. Water treatment plants at Elmore, Plymouth, and Reading have been completed within last few months, 8 others are under construction, and 4 others are soon to be placed under construction. Of these 15 projects, 7 involve lime-soda water-softening; 2, iron removal only; 3, iron-removal and zeolite softening; 2, zeolite softening only; and one, plain filtration. When these plants are completed, there will be in Ohio 20 plants for iron removal only, 58 plain filtration plants, and 58 water softening plants.—*G. C. Houser.*

Buffalo Officials Summoned to Hearing on Niagara River Pollution. Health News (N. Y. State Dept. of Health), **12**: 9, 33, March 4, 1935. Officials of city of Buffalo were notified to appear before State Commissioner of Health at public hearing in Buffalo on March 11 to show cause why present sewage pollution of Niagara River should not be discontinued. There have been 3 occasions during last 2 years when safety and health of over 130,000 persons living in municipalities along Niagara River below Buffalo have been endangered by unreasonable load placed on their purification plants by Buffalo sewage pollution. This has constituted distinct menace to public health of residents of Tonawanda, North Tonawanda, Niagara Falls, Lockport, Lewiston, Youngstown, and Fort Niagara, which derive their public water supplies from Niagara River.—*G. C. Houser.*

Upstate Sanitation Projects Completed under PWA in 1934. Health News (N. Y. State Dept. of Health), **12**: 9, 36, March 4, 1935. Eighteen water supply and sewerage projects, representing total expenditure of nearly $1,000,000, were completed by New York State communities during 1934 under PWA program. One of most important of these improvements was construction of new impounding reservoir and filtration plant by village of Goshen. Other communities that improved and extended their present waterworks systems were:—Mount Morris, Croton, Saranac Lake, White Plains, Plattsburg, Pleasantville, and Irvington. Taxpayers of unincorporated village of Holland organized water district, constructing new source of supply and complete distribution system.—*G. C. Houser.*

Santa Barbara Regulates Bottled Water Business. Weekly Bulletin, California Department of Public Health, **14**: 7, 26, March 16, 1935. City of Santa Barbara has enacted an ordinance which regulates bottled water business within that city. It provides for issuance of permits to bring or receive into

city or to sell any bottled water for human consumption in containers holding one gallon or more of water. Water supply must be protected, sanitary equipment provided, and proper labeling maintained. Bottling plant must be kept in clean and sanitary manner. Bottled water must conform to present standard for drinking water as promulgated by U. S. Public Health Service.—*G. C. Houser.*

Cess-pool and Shallow Water Supplies. F. C. ROBERTS, Jr. Arizona Public Health News, No. 109, March, 1935. Many sections of state depend on shallow water strata for their drinking and commercial water. From analyses of the shallow supply it appears that these strata are often contaminated. There are several reasons for this condition; chief among them being possibly the cess-pool. As contents of cess-pool rise, pressure on bottom deposit must develop, with probable effect of forcing sewage out into broad area in surrounding gravel, or water stratum. Here in Arizona, where we depend on subsurface strata for our water supply, it is essential to health to keep the substrata clean. Therefore, State Board of Health is advocating abandonment of cess-pool as means of sewage disposal.—*G. C. Houser.*

Carrying Coals to Newcastle. Health (N. H. State Board of Health), March, 1935. A New Hampshire resident wrote to State Board of Health stating that it was necessary for him to use a soft water comparatively free from calcium and iron and that, as the spring water supplied him for past 6 years in carboys from Pennsylvania, was proving expensive, he wondered if Board could recommend some bottled water of nearer origin. In response it was stated that water supply of town of Littleton, near him, is virtually spring water, being very soft and very pure, probably as good for him as any water that might be shipped from Pennsylvania. About the same could be said of Woodsville supply, also near him.—*G. C. Houser.*

Journal of the Pennsylvania Water Works Operators' Association, Volume 7, 1935. 6 x 9 inches. I. M. Glace, Secy.-Treas., 22 South 22nd Street, Harrisburgh, Pennsylvania. This volume includes papers given at the 8th Annual Conference of the Association, held at State College, Pennsylvania, June 25, 26 and 27, 1934. **Fire Protection.** W. C. HAWLEY. 47–58. Primary factors in the design of a water supply system for fire protection service are:—adequate sizes of pipes, proper allowance for depreciation of capacity with age, careful and dependable types of construction, a sufficiency of valves and their installation with adequate provision for maintenance, frequently spaced hydrants of appropriate design with provision for least interruption due to traffic damage, and fair allocation of cost of fire protection as part of general water supply service. **Discussion.** In cities having fire departments with pumpers, prime requisite of water supply is volume, and not pressure. **The Causes of Tastes and Odors, and Methods of Correction.** N. J. HOWARD. 59–74. Common causes of tastes and odors in waters are micro-organisms; chemical reactions liberating noxious gases; decomposition of organic matter; industrial wastes and sewage pollution; chlorine; formation of substitution compounds of chlorine with algae, trade wastes, and decomposing organic

matter; and after-treatment tastes and odors. Practicable methods of treatment include aëration, permanganate, super- and de-chlorination, ammonia-chlorine, activated carbon, bleaching clay, and ozone. Each case requires a critical appraisal of the values of the treatment to eliminate specific causes. Permanganate is useful for tastes associated with micro-organisms, faint chloro-phenols, and some industrial wastes. Ammonia-chlorine is effective with micro-organisms and with chloro-phenols not accompanied by organic matter. Super- and de-chlorination is useful with some micro-organisms and with coal tar and oil wastes. Activated carbon, alone or in combination with other processes, is the most generally effective re-agent. **Discussion.** Combination of activated carbon and ammonia-chlorine treatments was found most effective in elimination of tastes due to combination of vegetable growths and industrial pollution. **A Correlation of Differential Tests for the Colon-Aërogenes Group.** R. D. HOAK. 75–93. Concise review of investigational work over past thirty years, of abstracts of investigators' opinions on the sanitary significance of the colon-aërogenes group and of certain organisms outside that group, as well as of extraneous forms that confuse tests for that group. Critical evaluation of media using dyes as inhibitory agents includes brilliant green, gentian violet and crystal violet, basic fuchsin, Dominick-Lauter medium, methyl red and Voges-Proskauer reactions, citrate, cellibiose, indol production, uric acid, EMB, ferrocyanide-citrate agar and solid brilliant green lactose bile. It is apparent that, excepting the direct pour-plate methods, none of the differential tests mentioned can be relied upon to give dependable results without the supporting evidence of other related tests. Author's experiments on brilliant green bile, crystal violet broth, and brom cresol purple broth show some vagaries of identification by any single method. Bibliography. **Typhoid Fever.** C. F. DRAKE. 94–133. Critical analysis of the trends in typhoid fever death and case rates in the United States at large compared with other countries of the world, in the states by sectional groups, in cities and rural areas, and in Pennsylvania in particular, show a definite relation between incidence of typhoid fever and lack of public water supply. Seasonal trends in typhoid case rates vary significantly in different sections of the country. Improved public water supplies and sewerage can so reduce typhoid fever incidence as to put the United States, in the forefront of the nations of the world in this respect. **Discussion** cites instances of shellfish as bearers of typhoid and lists some recent typhoid outbreaks. **The Lack of Responsibility of Water Works Officials for Typhoid Fever.** J. A. BECK. 134–148. Supplier of water for human consumption must exercise every reasonable effort to ascertain quality of water supplied and take every reasonable precaution to render it safe. Municipalities, exempt from liabilities for injuries caused in course of governmental duties, are liable for injuries resulting from corporate functions, including water supply. Plaintiff must establish that water actually caused typhoid fever, that supplier was negligent in allowing or failing to prevent the pollution and that injured party was not guilty of contributory negligence. Employees operating plants, if negligent, are primarily liable and subject to suit not only by the party, but also by the employer. **Discussion.** Description of Olean, New York, epidemic and its consequences. **Public Relations.** W. L. EISERT. 149–155. Personnel, plant, equipment,

and business methods of an operating water utility come under public scrutiny and furnish basis for public attitude toward water supply organization. As much thought and effort should be invested in improvements of these factors as in advancement of technical operation. **Modern Methods of Water Purification.** R. S. WESTON. 156–167. Development of new coagulants, determination and interpretation of pH, correction of corrosive influences, elimination of tastes and odors, better flocculation, chlorination and ammoniation, and deferrization and demanganization characterize a new era in water purification. **Recent Progress in the Art of Water Supply.** T. H. WIGGIN. 168–180. Dams, piping lines, protective coatings, rehabilitation of old mains, improved pipe-jointing materials, better designed valves, new service-pipe materials, hydrants adapted to modern traffic hazards, metering devices, and purification plant equipment have received critical attention within recent years.—*R. L. McNamee.*

Papers. Tenth Annual Michigan Conference on Water Purification, September 11–13, 1935. Bulletin 66. Michigan Engineering Experiment Station, East Lansing, Michigan. 6 x 9 inches, paper. 76 pages. 25¢. **Use of Municipally Treated Waters in Steam Boilers.** L. F. COLLINS. 5–19. Objectives of boiler water treatment are prevention of scale, of corrosion, and of steam contamination. This usually requires specific treatment at the boiler plant; but much can be done to lighten the load upon this treatment by production of a stable, balanced water of low concentration and constant composition, containing little or no sodium salts. **Plankton of Inland Waters.** F. E. LYMAN. 20–24. Clear presentation of essentials of limnology, as it concerns the water purification scientist. **Carborundum Plates at Grand Rapids, Michigan.** H. T. CAMPION. 25–27. Six month's experience with carborundum plates as filter underdrainage, with sand placed directly above the plates, indicates that greatly increased wash rates can be obtained over those previously possible with ridge and furrow or perforated strainer type of bottom. **Bromides a Potential Source of Tastes in Water Supplies.** L. B. HARRISON. 28–29. Persistent medicinal tastes in a treated water supply contaminated with oil field and chemical plant brines are believed to be due to following series of conditions:—(1) free chlorine in presence of bromide may release in the water 2.25 times its weight of free bromine; (2) heating, such as may take place in domestic hot water systems, may decompose bromides and liberate free bromine; and (3) bromophenolic tastes and odors are more pronounced and more lasting than chlorophenolic. **Utilization of Diesel Engine Byproducts in a Water Softening Plant.** PAUL STEGEMAN. 30–35. Hot water for lime slaking and for general plant uses taken from jacket cooling system, building heating recovered from exhaust gases through waste heat boiler, and carbon dioxide for softening treatment secured by compressing exhaust gases together with low cost of power produced by engine reduced by 38 percent power bill at Midland, Michigan, water softening plant. **Underdrain Failures.** H. G. HELGESON. 36–37. Alpena, Michigan, filter underdrainage, consisting of perforated pipes, was rehabilitated and sand washed with caustic soda and soda ash in boiling water by Relief labor, at total cost of slightly over $1,000. **Unusual Bacterial Counts in Flint River.** E. H.

BURDICK. 38–41. Concurrence of high chlorine demand of Flint River water with aftergrowths in plant processes has been found to exist under anomalous conditions; bacteria were present in large numbers at points where count would be expected to be low; but were low at points of pollution; bacterial content multiplies readily in presence of large amounts of chlorine, but less readily in presence of ammonia. Bacterial life continues through coagulation basins, where food is available but dies off in distribution mains. **Brilliant Green Bile Broth Compared with Standard Method in 1933.** Committee Report. 42–50. Concludes that B.G.B. confirmatory procedure is superior to that of standard methods 1933 as routine procedure for measuring the colonaërogenes group in filtration plant operation. **Well Water Supplies.** Committee Report. 51–52. Local plant chemists and bacteriologists should analyze water samples for local residents in accordance with general method approved by State Department of Health. **Small Well Construction and Sanitation.** 53–54. Sanitary survey of well site is very desirable aid to interpreting well water analysis. **The Saginaw Valley Brine Problem.** 55–65. **Part I. Geologic Aspect.** G. E. EDDY. Recent rapid development of oil industry in Michigan has seriously affected water purification plants using surface waters from drainage basins on which wells are situated. Six means of disposal of oil field brines are available:—(1) return to subsurface formations; (2) evaporation ponds; (3) artificial evaporation to recover valuable constituents; (4) diversion into selected streams; (5) plugging off in the well; and (6) use as dust layer on gravel roads. Michigan problem is now in its ascendancy. **Part II. River Aspect.** T. J. POWERS. Oil filled brines seriously affect fish life, plant life and vegetation, and live stock, as well as complicating the problems of water treatment plants. **Part III. Water Treatment Aspect.** ALFRED ECKERT. High and widely varying concentrations of oil field and chemical plant brines produce an almost intolerable condition at downstream water treatment plants. **Typhoid Fever in Michigan.** R. G. FAUST. 66–72. Review of history of typhoid fever epidemics in Michigan and of beneficial effects of water treatment.—*R. L. McNamee.*

Run-Off Formulas and Methods Applied to Selected Ohio Streams. J. C. PRIOR. Engineering Experiment Station. Bulletin 49: Ohio State University, 1929. 6 x 9 inches, paper. Price 50¢. Studies of Scioto and Miami Rivers and of Raccoon Creek show wide differences in adjacent water sheds. Author concludes that in present state of science of hydrology, there seems to be no adequate substitute for actual stream flow measurements for obtaining annual runoff. Where actual flow records are available over a period of at least ten years, it is probably possible to compute annual runoff in other years, for which only rainfall and other physical data are available, with an extreme error for any year of less than 100 percent; but errors of 50 percent may not be uncommon and mean annual error may amount to 25 percent. On streams where no observed runoff records are available, to be used as guides, errors to be expected in applying annual runoff formulas and methods may easily exceed those limits, suggested in the preceding paragraph. If a simple formula is desired, it is believed that $F = \frac{2}{3} R - B$, in which the constant B is selected to fit each particular stream, will probably approximate most nearly the true

annual runoff on Ohio streams. When runoff years end September 30, the best calculated runoff will be obtained by ending rainfall years June 30. Besides ending the rainfall year previous to end of runoff year, it may be well to consider also the rain of the preceding year in computing stream flow. Runoff characteristics of one stream may be entirely different from those of another, even though they may be situated side by side. General slope of drainage basin, which includes soil character and cultivation, will have pronounced effect upon the amount of water appearing as runoff. Year-to-year variations in annual mean temperature seem to have little or no influence upon annual runoff. Largest computed stream-flow errors, in inches, will probably occur in years of abnormally heavy runoff and largest percentage errors are apt to come in years of scanty runoff. Calculated amounts of runoff for short periods, say a month or less, will be subject to such large errors as to make them valueless, except for very rough approximations. Runoff formulas derived from experience in other sections of the country should be used in Ohio with extreme caution.—*R. L. McNamee.*